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Issued July 28, 1911.

U. S. DEPARTMENT OF AGRICULTURE,

BUREAU OF SOILS.

FIELD OPERATIONS OF THE BUREAU OF SOILS, 1908.

[TENTH REPORT.]

BY

MILTON WHITNEY, Chief.

WITH

ACCOMPANYING PAPERS BY ASSISTANTS IN CHARGE OF FIELD PARTIES.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1911.

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[PUBLIC RESOLUTION—NO. 9.]

JOINT RESOLUTION Amending public resolution numbered eight, Fifty-sixth Congress, second session, approved February twenty-third, nineteen hundred and one, "providing for the printing annually of the report on field operations of the Division of Soils, Department of Agriculture."

Resolved by the Senate and House of Representatives of the United States of America in Congress assembled, That public resolution numbered eight, Fifty-sixth Congress, second session, approved February twenty-third, nineteen hundred and one, be amended by striking out all after the resolving clause and inserting in lieu thereof the following:

That there shall be printed ten thousand five hundred copies of the report on field operations of the Division of Soils, Department of Agriculture, of which one thousand five hundred copies shall be for the use of the Senate, three thousand copies for the use of the House of Representatives, and six thousand copies for the use of the Department of Agriculture: *Provided*, That in addition to the number of copies above provided for there shall be printed, as soon as the manuscript can be prepared, with the necessary maps and illustrations to accompany it, a report on each area surveyed, in the form of advance sheets, bound in paper covers, of which five hundred copies shall be for the use of each Senator from the State, two thousand copies for the use of each Representative for the Congressional district or districts in which the survey is made, and one thousand copies for the use of the Department of Agriculture.

Approved, March 14, 1904.

[On July 1, 1901, the Division of Soils was reorganized as the Bureau of Soils.]

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LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF SOILS,
Washington, D. C., May 24, 1910.

SIR: I have the honor to transmit herewith the manuscript report, with accompanying illustrations and maps, of the field operations of the Bureau of Soils in 1908, the publication of which is authorized by public resolution No. 9 of the Fifty-eighth Congress, second session.

Respectfully,

MILTON WHITNEY,
Chief of Bureau.

Hon. JAMES WILSON,
Secretary of Agriculture.

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FIELD OPERATIONS OF THE BUREAU OF SOILS.

1908.

By MILTON WHITNEY, Chief.

GENERAL REVIEW OF THE WORK.

PROGRESS OF THE SURVEY.

At the close of the field season for the calendar year 1907 an area of 149,507 square miles, or 95,684,480 acres, had been covered by detailed soil surveys. The work of the detailed soil survey for the calendar year 1908 covered 22,280 square miles, or 14,259,200 acres, showing an increase of 2,809 square miles, or 1,797,760 acres, over the area covered by detailed soil surveys in 1907, and bringing the total area surveyed up to 171,787 square miles, or 109,943,680 acres. During the calendar year 1908 from ten to twenty-one field parties of two men each were maintained in the detailed soil-survey work, and within this period work already begun in seven areas was completed and work was undertaken in thirty-six additional areas, of which twenty-eight were completed before the end of the year, making thirty-five areas surveyed in detail in 1908.

The average cost of the field work in the detailed soil surveys in 1908 was $3.33 per square mile, an increase of 4 cents per square mile over the average for 1907.

In addition to the detailed soil surveys, reconnoissance soil surveys were conducted in the Great Plains and Appalachian regions. An area of 39,240 square miles, or 25,113,600 acres, was thus surveyed in western North Dakota, and an area of 3,000 square miles, or 1,920,000 acres, was covered in south Texas. Both of these surveys are in the Great Plains region. In the Appalachian region an area of 8,112 square miles, or 5,191,680 acres, was also covered by reconnoissance soil surveys in northwestern Pennsylvania.

The tables following give in detail the location, extent, and cost of both the detailed and reconnoissance soil surveys conducted during the calendar year 1908, the work previously completed, and also the total area thus far covered by soil surveys in the different States and Territories of the United States.

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Areas surveyed during the year ending December 31, 1908, and areas previously reported.

DETAILED.

State or Territory.	Work during 1908.	Work previously reported.	Total.	
	Sq. miles.	*Sq. miles.*	*Sq. miles.*	*Acres.*
Alabama	6,189	10,071	16,260	10,406,400
Arizona	.....	859	859	549,760
Arkansas	.....	2,677	2,677	1,713,280
California	1,595	8,002	9,597	6,142,080
Colorado	.....	2,428	2,428	1,553,920
Connecticut	.....	505	505	323,200
Delaware	.....	314	314	200,960
Florida	.....	2,955	2,955	1,891,200
Georgia	1,000	2,425	3,425	2,192,000
Idaho	.....	1,281	1,281	819,840
Illinois	.....	5,921	5,921	3,789,440
Indiana	667	3,544	4,211	2,695,040
Iowa	.....	2,303	2,303	1,473,920
Kansas	.....	3,180	3,180	2,035,200
Kentucky	.....	2,078	2,078	1,329,920
Louisiana	1,319	5,995	7,314	4,680,960
Maine	530	.....	530	339,200
Maryland	.....	3,576	3,576	2,288,640
Massachusetts	.....	809	809	517,760
Michigan	572	3,788	4,360	2,790,400
Minnesota	.....	2,197	2,197	1,406,080
Mississippi	1,356	5,705	7,061	4,519,040
Missouri	866	5,045	5,911	3,783,040
Montana	.....	432	432	276,480
Nebraska	.....	3,116	3,116	1,994,240
New Hampshire	.....	923	923	590,720
New Jersey	.....	1,303	1,303	833,920
New Mexico	.....	129	129	82,560
New York	1,034	5,598	6,632	4,244,480
North Carolina	1,157	8,613	9,770	6,252,800
North Dakota	1,453	4,552	6,005	3,843,200
Ohio	.....	4,143	4,143	2,651,520
Oklahoma	.....	1,163	1,163	744,320
Oregon	249	442	691	442,240
Pennsylvania	801	4,037	4,838	3,096,320
Porto Rico	.....	330	330	211,200
Rhode Island	.....	1,085	1,085	694,400
South Carolina	425	6,346	6,771	4,333,440
South Dakota	.....	674	674	431,360
Tennessee	1,234	4,751	5,985	3,830,400
Texas	858	12,427	13,285	8,502,400
Utah	.....	1,501	1,501	960,640
Vermont	.....	227	227	145,280
Virginia	.....	5,983	5,983	3,829,120
Washington	.....	1,652	1,652	1,057,280
West Virginia	975	1,576	2,551	1,632,640
Wisconsin	.....	2,537	2,537	1,623,680
Wyoming	.....	309	309	197,760
Total	22,280	149,507	171,787	109,943,680

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Areas surveyed during the year ending December 31, 1908, and areas previously reported—Continued.

RECONNOISSANCE.

State or Territory.	Work during 1908.	Work previously reported.	Total.	
	Sq. miles.	*Sq. miles.*	*Sq. miles.*	*Acres.*
North Dakota	39,240	.....	39,240	25,113,600
Pennsylvania	8,112	.....	8,112	5,191,680
Texas	3,000	.....	3,000	1,920,000
Total	50,352	.....	50,352	32,225,280

Areas surveyed and mapped, and cost of field work, January 1 to December 31, 1908, inclusive.[a]

DETAILED.

State or Territory.	Area.	Area surveyed.	Cost per square mile.	Total cost.
		Sq. miles.		
Alabama	Autauga County	595	$4.84	[b] $2,877.35
	Baldwin County	480	5.80	[c] 2,781.84
	Bibb County	630	3.80	[d] 2,391.12
	Calhoun County	621	3.24	[e] 2,009.71
	Colbert County	600	3.96	2,373.46
	Cullman County	741	2.67	[f] 1,981.19
	Etowah County	542	3.43	[g] 1,861.45
	Henry County	[h] 420	6.50	[i] 2,731.50
	Jefferson County	1,124	1.82	[j] 2,043.13
	Lamar County	[h] 436	2.55	[k] 1,113.18
California	Modesto-Turlock area	[h] 358	6.75	2,415.80
	Pajaro area	108	6.53	705.57
	Portersville area	329	6.29	2,068.00
	Yolo area	500	4.48	2,241.29
	Marysville area	300	5.90	1,768.57
Georgia	Grady County	460	2.94	1,351.61
	Thomas County	540	2.94	1,586.67
Indiana	Allen County	667	2.49	1,661.54
Louisiana	Bienville Parish	812	3.30	2,676.80
	East and West Carroll parishes	[h] 507	2.62	1,329.93
Maine	Caribou area	530	2.94	1,557.93
Michigan	Wexford County	572	.98	558.19
Mississippi	Clay County	141	2.80	395.17
	Holmes County	[h] 454	1.30	588.92
	Monroe County	761	5.03	3,828.58

[a] This includes the salaries of the men while in the area and their subsistence expenses, but not cost of transportation to and from the area.
[b] Of this amount $1,320.49 was paid by the State of Alabama.
[c] Of this amount $1,425.81 was paid by the State of Alabama.
[d] Of this amount $459.80 was paid by the State of Alabama.
[e] Of this amount $959.48 was paid by the State of Alabama.
[f] Of this amount $1,011.66 was paid by the State of Alabama.
[g] Of this amount $990.13 was paid by the State of Alabama.
[h] These figures do not include sections of these areas surveyed in preceding years.
[i] Of this amount $1,003.50 was paid by the State of Alabama.
[j] Of this amount $885.44 was paid by the State of Alabama.
[k] Of this amount $563.68 was paid by the State of Alabama.

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Areas surveyed and mapped, and cost of field work, January 1 to December 31, 1908, inclusive—Continued.

DETAILED—Continued.

State or Territory.	Area.	Area surveyed.	Cost per square mile.	Total cost.
		Sq. miles.		
Missouri	Bates County	866	2.58	2,238.30
New York	Livingston County	629	3.77	[a] 2,370.51
	Montgomery County	405	3.56	[b] 1,442.67
North Carolina	Caswell County	400	4.66	[c] 1,865.76
	Pitt County	122	3.47	[d] 423.45
	Robeson County	[e] 635	3.73	[f] 2,366.45
North Dakota	Richland County	1,453	2.46	[g] 3,573.20
Oregon	Klamath reclamation project	249	6.32	1,572.81
Pennsylvania	Center County	[e] 801	2.74	2,195.86
South Carolina	Anderson County	350	1.40	490.87
	Conway area	75	4.92	368.69
Tennessee	Coffee County	441	2.45	1,078.63
	Overton County	433	1.77	765.67
	Sumner County	360	2.32	836.45
Texas	Camp County	203	6.06	1,229.45
	Corpus Christi area	363	3.86	1,400.42
	Franklin County	292	4.54	1,326.39
West Virginia	Parkersburg area	975	1.74	[h] 1,695.49
	Total	22,280	3.33	74,139.57

RECONNOISSANCE.

North Dakota	Western section	39,240	$0.27	$10,462.97
Pennsylvania	Northwest section	8,112	.33	2,689.29
Texas	Southern section	3,000	1.00	3,001.14
	Total	50,352	.32	16,153.40

[a] Of this amount $853.55 was paid by the New York State College of Agriculture.
[b] Of this amount $520.43 was paid by the New York State College of Agriculture.
[c] Of this amount $392.46 was paid by the North Carolina department of agriculture.
[d] Of this amount $119.06 was paid by the North Carolina department of agriculture.
[e] These figures do not include sections of these areas surveyed in preceding years.
[f] Of this amount $600 was paid by the North Carolina department of agriculture.
[g] Of this amount $1,000 was paid by the agricultural and economic geological survey of North Dakota.
[h] Of this amount $607.55 was paid by the West Virginia geological survey.

COOPERATION WITH STATE ORGANIZATIONS.

The Bureau of Soils has continued the previous cooperative agreements and has entered into new arrangements for the conduct of soil-survey work in cooperation with several other States.

Thus in Alabama the state department of agriculture and industries has cooperated with the Bureau of Soils throughout the calendar year 1908, furnishing four state assistants and allotting from state funds to carry on the soil survey work the sum of $8,620. As a result it was found possible to complete the soil surveys of two

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counties previously undertaken, and in addition to begin soil-survey work in eight more counties, of which seven were completed. As a result of this cooperative soil survey work a total area of 6,189 square miles, or 3,960,960 acres, was completed in Alabama in the calendar year 1908.

A cooperative soil-survey agreement with the New York State College of Agriculture was also arranged whereby that organization furnished good field assistants during a part of the year and expended $1,374 in the conduct of soil-survey work in New York State. As a result, soil surveys of two counties, covering 1,034 square miles, or 661,760 acres, were completed.

The cooperative soil-survey work in conjunction with the North Carolina state department of agriculture was continued, and that organization maintained two field assistants working in connection with the soil-survey parties and expended $1,111 in soil-survey work. As a result, an area of 1,157 square miles, or 740,480 acres, was surveyed in the State during the calendar year.

In North Dakota the cooperation with the North Dakota agricultural and economic geological survey was continued during the year, and an area of 1,453 square miles, or 929,920 acres, was completed, the state organization furnishing the sum of $1,000 toward the expenses of the work.

During the same period cooperation with the West Virginia geological survey was conducted, and an area of 975 square miles, or 624,000 acres, was covered by soil surveys in the State. The state organization contributed $607 toward the expense of this work.

Additional arrangements for cooperative soil-survey work are now in operation. The area covered by soil surveys during each calendar year is being considerably extended through the interest of the state organizations and their active support, both in the furnishing of men and funds.

REQUESTS FOR SOIL SURVEYS.

The number of requests for soil surveys on file at the Bureau of Soils has again decidedly increased. There were on file on December 31, 1908, requests for 654 additional areas, covering an aggregate of 650,000 square miles of country, in regard to which it had been impossible to take action. There are thus on file requests for additional work which would cover an area nearly four times as great as the Bureau has been able to cover from May, 1899, to January, 1908.

The requests are received from every section of the United States and represent practically all of the great agricultural interests of the country. There is an increasing demand for soil surveys which shall investigate soils particularly fitted for the production of special

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crops, and this demand indicates the present tendency of American agriculture toward a greater degree of specialization in crop production and in the farming practice of the country.

SURVEY OF THE RECLAMATION PROJECTS.

As far as practicable, requests for detailed soil surveys of the federal reclamation projects have been met during the year. Work on the Klamath reclamation project was completed by the soil survey and the report issued.

EXTENSION OF THE SOIL SURVEY.

The systematic extension of the soil-survey work into all parts of the United States has been undertaken by the Bureau of Soils, and as far as possible new areas have been assigned with especial reference to studying soil conditions in representative regions not heretofore investigated by the Bureau. Soil surveys have now been made in every State and Territory of the country, and one or more soil surveys have been made in practically every important agricultural region. In this way a fundamental knowledge has been gained of all of the more important soil types throughout the United States and of the most important soil problems affecting these types. With the progress of the soil surveys this knowledge will be extended and strengthened.

During the calendar year 1908 a new class of soil-survey work was undertaken in the region lying west of the one hundredth meridian, work being started both in North Dakota and Texas to determine the character of the soil and crop adaptations of the soils in the Great Plains region. This work will be continued until a reconnoissance survey of the Great Plains section from the Canadian boundary line to the Rio Grande River has been made. Similar work has also been begun in the study of the possible extension of agriculture through the cut-over timber lands of the Great Lakes section, and arrangements have been made for the study of the cut-over timber lands of the Puget Sound region in conjunction with the state authorities of Washington. Provision should be made at an early date for a systematic examination of the large areas of swamp land which constitute the reserve supply of agricultural land of greatest importance east of the one hundredth meridian.

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SOIL SURVEY OF THE CARIBOU AREA, MAINE.

By H. L. WESTOVER and R. W. ROWE.

DESCRIPTION OF THE AREA.

The survey of the Caribou area, Maine, covers 339,200 acres, or 530 square miles, situated along the eastern border of Aroostook County, the southernmost point extending 9 miles south of parallel 46° 30′, and the northern border to within 3 miles of parallel 47° north latitude. Meridian 68° west of Greenwich divides the area into two unequal parts, that on the east being 9 miles in width and that on the west approximately 6 miles in width. The area extends a distance of 40 miles north and south and has a maximum width of 15 miles. The irregularity of the southwest corner of the area is due to the absence of roads and the thickly forested conditions of the county in this section, which made it impossible to carry the work as far west as was originally intended.

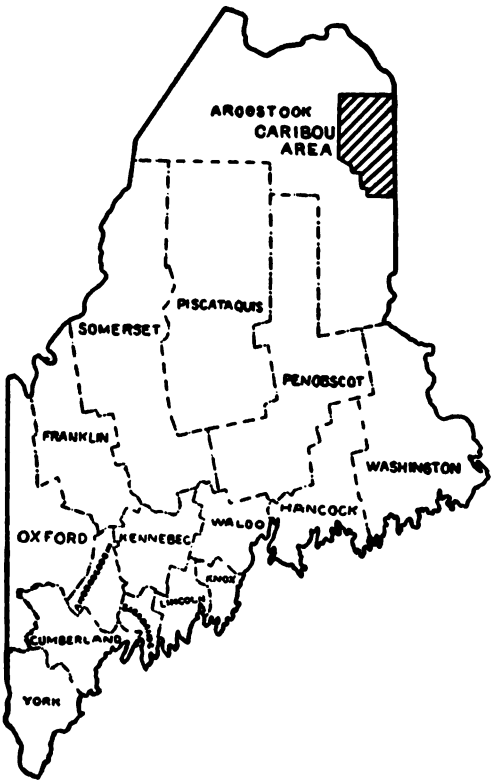

FIG. 1.—Sketch map showing location of the Caribou area, Maine.

The eastern boundary of the area is formed by the Province of New Brunswick and the southern boundary by the township of Monticello, Aroostook County. The western boundary is an arbitrary line that separates the northern half of New Sweden Township into two nearly equal parts and then passes south through the middle of Washburn, Woodland, Mapleton, and Chapman for a distance of 28 miles. It then narrows by successive steps to the east, until at the southern

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extremity the area has a width of only 4 miles. The northern boundary, also an arbitrary line, passes east and west through the townships of Caswell and Connor, about one-fourth mile north of the line separating them from Caribou and Limestone townships and continuing west through the eastern half of New Sweden. As completed the survey included the full townships of Limestone, Easton, Mars Hill, and the greater part of Bridgewater; the double townships, Fort Fairfield, Presque Isle, and Caribou; the half township Blaine; and parts of Township 10, Townships D and E, New Sweden, Caswell, Connor, Woodland, Washburn, Mapleton, Chapman, and Westfield.

The larger part of the area is a rolling plain, having an average elevation of about 500 feet and consisting of a series of broad ridges and swells with level tops and with slopes that descend gradually to the streams. With few exceptions the flat country is occupied by swamps, which in many cases probably represent the remains of old lakes that have gradually filled up with accumulations of vegetable matter and with soil washed in from adjoining slopes. These swampy areas are found in all townships, but are more common and of larger extent in the southern part of the area, where, as a rule, the average elevation is somewhat less than farther north.

The hilly portion of the area is found principally west and southwest of Presque Isle. Three miles southwest of this village there is a prominent group of hills known as Hobart Hill, which rises from 200 to 300 feet above the level of the surrounding country. To the south there is a chain of mountains, with an elevation of 300 to 400 feet above the general level of the country, extending several miles in a southeasterly direction. Quaggy Joe (Quaquajo) and Green Mountain are the most prominent points of this chain. The most noted, as well as the highest point in the area, however, is Mars Hill, located just east of the village of that name. This hill has an elevation of 1,695 feet above tide level and is 2½ miles long and 1 mile wide. Knolls of morainal material are prominent surface features in sections of the area.

The area is drained by tributaries of the St. John River, of which the most important is the Aroostook River. This river, with its three main tributaries, the Presque Isle Stream on the south and the Caribou and Limestone streams on the north, drains the greater portion of the area. The southeastern part is drained by Prestile (Presque Isle of the St. John) Stream and the River du Chute and confluent streams.

Many small lakes and ponds occur throughout the area, but they are very shallow and are being gradually filled with soil and vegetable matter. The largest of these are Caribou, in Washburn Township, and Quaggy Joe, at the foot of the mountain of that name.

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The settlement of the region now included within the limits of Aroostook County was begun at Fort Fairfield in 1816 by families from New Brunswick. A few years later the settlement of Presque Isle began, and finally about twenty years later the first real settlers found their way to Caribou. It was not until the opening of the military road to Presque Isle in 1837 that people began coming in from the southern part of the State. The building of this road, coupled with the liberal policy of the State in allowing the settlers to take up claims of 160 acres and pay for them at the rate of 50 cents an acre within three years in work on their own roads at $1.50 per day, encouraged immigration and people came in more rapidly. The county was organized in 1839 and enlarged to its present dimensions in 1843. It was made up of portions of Washington and Penobscot counties and the later addition was made from Piscataquis and Somerset counties. At the time of its incorporation the population numbered approximately 9,000 people, mostly French, with a few English traders. After this the settlement was very rapid and the number of English settlers increased rapidly.

In 1870, through the efforts of the commissioners in the settlement of public lands, a colony of Swedes was induced to settle in the county, the section where they took up land being made a township, with the name of New Sweden. Later in the same year and in succeeding years other immigrants came to the colony, and to-day they have one of the finest farming sections in the area. In 1890 the population of the county had reached 49,589 and in 1900 it was 60,744—a most remarkable growth.

Thus, with the Swedes in New Sweden, a large number of French in the northern part of Caribou Township, and with a mixture of French, Irish, and English in other sections, the population is somewhat varied. As indicated by the appearance of the buildings and farms in general, the county is prosperous. Nowhere in New England does one find better farm buildings. The houses are usually large and well built, the barns and potato cellars are substantial, commodious, and warm, and an unpainted building is the exception. The farms are equipped with modern machinery, potato diggers, potato planters, mowers, and reapers. Good driving horses and carriages are found on almost every farm. The greater number of homes have telephones and rural free delivery of mail. In most sections roads are numerous and as a rule kept in excellent repair. Comparatively few of the farms are mortgaged, and on these the debt is being rapidly lifted, while at the same time the land and buildings are being improved.

During the greater portion of the year nearly all the streams afford abundant water power, which in many cases has been developed to run sawmills and grist mills. With possibly one or two exceptions every village in the area has water power.

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Caribou, located in the northern part of the area, on the Aroostook River, is probably the most populous town. It is followed closely by Presque Isle and Fort Fairfield, the latter being located in the eastern part of the area, on the Aroostook River, and the former 12 miles south of Caribou, on the Presque Isle Stream, just 1 mile south of its junction with the Aroostook River. Other newer towns which are developing very rapidly are Limestone, Easton, Westfield, Robinsons, Bridgewater Center, Mars Hill, and Blaine.

The transportation facilities are exceptionally good, and no point in the area is more than 8 miles distant from the railroad. The main line is the Bangor and Aroostook Railroad. From Bangor the line runs north to Van Buren, passing through the heart of the potato section of Aroostook County. At Fort Fairfield Junction it divides, the main line continuing north through Presque Isle and Caribou, and finally reaching the St. John River at Van Buren, outside of the area. At Caribou another branch runs to Limestone. In addition to these a branch of the Canadian Pacific Railway enters the area near Fort Fairfield, and follows the Aroostook River to Caribou, terminating at Presque Isle.

Boston is the principal market for all crops except potatoes. The greater part of this crop is sold direct to buyers at the local markets, very few potatoes being shipped out of the area by farmers.

CLIMATE.

As there is no Weather Bureau station within Aroostook County with complete records, no climatic data can be furnished for the area surveyed.

The winters are long and severe, but the cold is less noticeable than in the southern part of the State, where the humidity is considerably greater. January and February are the coldest months, while July and August are the hottest months. There is seldom a winter when the thermometer does not at some time drop as low as −40° F., but at such times the cold is not so noticeable, because the air is very still and dry.

The summers are comparatively short and cool, though brief periods of extreme heat and high humidity occur.

Frosts have been known to occur every month in the year, but they are very rare in July. Light frosts in early June and the latter part of August are not uncommon, and killing frosts have been known to occur in these months.

Snow usually falls before the ground freezes in the fall and remains as a heavy covering throughout the winter. When it melts the following spring the waters drain off rapidly and the land can be worked almost immediately.

The annual precipitation is fairly well distributed throughout the year, although droughts sometimes occur during the summer months.

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The soils, however, withstand these droughty periods to a reasonable degree and crops seldom suffer as they do in some other sections of New England.

The prevailing winds are from the northwest. Easterly winds from the coast usually bring rain. The general climatic conditions are said to be very healthful, while the death rate is somewhat less than in other sections of New England.

AGRICULTURE.

Aroostook County at the time of its first settlement was covered with a dense forest of evergreen and deciduous trees. The former included spruce, fir, cedar, and white pine, and the latter a great variety of species, prominent among which were beech, yellow birch, elm, ash, maple, tamarack, white birch, and poplar. The evergreen trees then, as now, were confined principally to the low, swampy lands, while the hardwoods occupied the ridges. Immense white pines, however, were found on all soils; and while the other trees are still abundant, this most valuable tree, which gave to the State the name "Pine Tree State," has become almost extinct within the area surveyed.

The first settlers and lumbermen regarded the white pine as the only tree worth marketing. Later the value of the spruce was recognized, and spruce lumber is now being shipped out of the county in immense quantities. There is no present danger of exhausting the supply, however, as the owners are following a more intelligent system of cutting than was employed in the earlier days of lumbering.

There are records showing that pioneers from New Brunswick settled at Fort Fairfield as early as 1816, and at Presque Isle a few years later. They cleared small tracts of land along the Aroostook River and farmed on a small scale during the summer months, but the greater portion of the year was devoted to lumbering. These settlers were almost entirely dependent on the timber, which they exchanged for the necessaries of life.

At the close of the war of 1812 the boundary line between Maine and New Brunswick was left unsettled, and there were border troubles between the United States and England for several years later, which resulted ultimately in the building of the military road from Bangor to Houlton soon after 1830. Later this road was extended to Presque Isle and Caribou. This was an important factor in the development of the region, as it gave an outlet to the markets of the southern part of the State.

Up to the time of the construction of this highway there were no large areas under cultivation. Small tracts had been devoted to the production of oats, rye, wheat, buckwheat, hay, and potatoes, for local consumption. In fact, practically all the food, as well as cloth-

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ing, was produced on the farm. There were, however, a few larger tracts of land which were devoted during the summer to the grazing of cattle and sheep. In the winter these, together with some hogs, were fed from the grain and hay produced on the farm, as it was found much easier to get the hay and grain to the distant markets in the form of beef, pork, mutton, and butter. Mills had already been established where the grain could be ground for the stock and for family use.

The various lumber camps, which were operated in the county during the winter months, furnished a market for a large part of the farm products. The great number of men employed in these camps consumed much of the meat and many of the potatoes and other vegetables, while the horses required almost all the oats and hay produced in the area.

Pioneers were drifting into the area from the provinces and from the southern part of the State all the time, and the population increased from 3,399 in 1830 to 15,527 in 1850.

Just prior to the civil war settlers came into the county in large numbers, and naturally there arose a great demand for a railroad connecting the county with the southern part of the State. To aid in the establishment of such a line, the State gave township after township to the European and North American Railroad, until in 1865, out of 175 townships, only 40 remained to the State. What was still worse, after giving up all these lands the county never received any direct benefit, although it was doubtless intended by the legislature and expected by the people that the line should extend as far north as Houlton.

But the civil war put a stop to these proceedings and at the same time checked the development of the county. However, after recovering from the effects of the war, the inhabitants renewed the clamor for a railroad, but finally despairing of getting a direct line to Bangor, asked the New Brunswick Company, which was constructing a line up the St. John Valley, to extend branch lines to Houlton and Fort Fairfield. This they did, completing the Houlton branch in 1862 and the Presque Isle branch in 1875. In 1876 the line was extended to Caribou, and finally, in 1881, to Presque Isle. This road served the county for twenty years, and although the line of shipment was indirect, it afforded an outlet for the products, and as a result the acreage under cultivation increased. Up to this time the type of agriculture had remained practically the same, the leading crops being oats, wheat, buckwheat, and hay, although dairying was gradually coming into prominence.

The construction of the first starch factory in 1874 marks the beginning of a revolution in agriculture. This industry, organized by Albe Holmes, a New Hampshire man, is probably, though indirectly, the outcome of the building of a branch line of the New

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Brunswick Railroad into Houlton and the promise of such a line into Fort Fairfield, thus bringing the region into better communication with the markets. This industry proved a success, and in a short time other factories were established at various points in the area where farmers would contract to grow enough potatoes to justify the building of such a factory, and thus the acreage devoted to potatoes rapidly increased. It frequently happened that more potatoes were grown than could be used at the starch factories, and as a result the farmers began shipping them. In a short time a demand for Aroostook potatoes was created, and under this stimulus the acreage showed a still greater increase, until, in 1891, 1,700,000 bushels of potatoes and 4,500 tons of starch were shipped out of the county.

During this time the population was rapidly increasing and the agricultural products were multiplying. As a result the clamor for a direct route to Bangor broke out afresh. So far all goods that passed over the New Brunswick Railroad, now the Canadian Pacific, had to be shipped under manifest. They were also a long time en route, and the rates were high.

Finally the construction of the Bangor and Aroostook Railroad was begun at Bangor in 1893. That fall it was completed to Houlton, and the following year, 1894, it reached Caribou and Fort Fairfield.

Although the acreage in potatoes showed a gradual increase, owing to the establishment of the starch industry, it was not until the opening of this road, which brought the area into direct communication with some of the southern markets, that the industry entered upon its present era. Since that time the potato has been, still is, and probably will continue to be the most profitable crop in Aroostook County. Each year large areas of new lands are devoted to this crop. It is to be regretted, however, that large areas of good potato soils in the county are held by lumber companies or by individuals, who refuse to sell them at any price, and who are content with the income realized from the lumber that is being removed. Land held in this way is bound to check the agricultural development of the county.

Next to potatoes in importance is the hay crop, the acreage of which is considerably larger than that of potatoes. At one time large quantities of grass and clover seed were produced for sale, but the practice has gradually been replaced by other forms of industry. Clover and timothy are now grown almost exclusively. The first crop from a newly seeded piece of land is principally clover, while the succeeding crops consist chiefly of timothy. Large quantities of the latter are shipped to Boston markets, and the income from this source is a very important item to the farmer. The quality is excellent, and the crop, as a rule, commands a good price. The average yield is from 1 to 2 tons per acre, depending, of course, on the condition of the land.

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Oats are grown on almost every farm, but not in sufficient quantities to supply the local demand, and each year large quantities are shipped into the area. There seems to be no necessity for this, as the yield of oats is large, the average being 50 bushels per acre, and they always bring a good price.

Wheat and rye were formerly grown by almost every farmer. At present, however, no crops of the latter are seen, while only small areas are devoted to the former for home consumption. Spring varieties are grown almost exclusively, the White Russian being the standard. The usual yield is from 25 to 30 bushels per acre.

Many of the farmers have small fields of buckwheat and barley. Both crops do well on the soils of the area. Barley yields from 40 to 50 bushels per acre.

Corn is only grown in the garden, as the season is too short for it to reach maturity.

In the early days the climate was thought to be too severe for the growing of apples and small fruits. About thirty-five years ago, however, when the farmers began in a small way to raise a few of the hardier varieties of applies, this idea was found to be erroneous. The Fameuse became a favorite, and as it was early and matured rapidly its successful culture was assured. The varieties that have proved the hardiest and best suited to Aroostook County are the Duchess, the Wealthy, the Fameuse, and Dudley's Winter. The townships which produce the larger proportion of the apples are Presque Isle, Mapleton, and Washburn. Blackberries, strawberries, raspberries, currants, and plums can also be successfully grown, but the climate is too severe for pears.

Vegetable and truck crops, with the exception of potatoes, do not receive the attention they should, and practically all the vegetables consumed in the towns are shipped in from Boston. That such crops can be successfully grown is shown by the excellent family gardens, where all kinds of truck products are found. The sandy areas along the Aroostook River should be especially well suited to such crops, and on the muck areas, if properly drained, onions and celery should do well.

More attention is being paid to the production of eggs and poultry than formerly, and there is ample opportunity for success along this line. Except for a short time in summer, not enough eggs are produced to supply the town trade, and in the late winter and spring many chickens and turkeys are purchased from outside markets for home use.

Dairying, which was at one time an important industry in the area, has gradually declined. Formerly several cheese factories, producing an excellent quality of cheese, were in operation, but at present none of these are in existence. Among the causes that have oper-

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ated to bring about these changes may be mentioned the increased interest in potato growing, which has been found more profitable and less confining than dairying. At present the only town in the area supporting a milk route is Caribou, where there are two successful dairy farms. Almost every farmer, however, keeps at least one or two cows, which furnish the family with milk and butter for a part of the year, and give a surplus for sale during a part of the summer. During the winter months creamery butter is shipped in from southern points. Many of the farmers, too, buy butter for family use. With milk selling at 6 cents a quart and good butter bringing 25 to 35 cents a pound, it would seem that a few well-regulated dairy farms in the area would pay handsomely.

The production of beef and mutton has fallen off considerably, although many farmers still have some excellent sheep, and there are one or two fine herds of beef cattle in the area. Enough mutton is produced to supply the home trade and leave some for export. The towns, however, depend principally on the West for their beef supply.

Special attention is paid to the raising of horses, and it is doubtful if any section in New England produces finer work and driving horses than are found in the area.

The value of forest products, while not large for the area surveyed, is of importance to the county as a whole, the total value in 1900 being $258,087. Considerable lumbering, however, is carried on in the area during the winter months, the lumber being chiefly obtained from the swamp land. At this time of the year many of the farmers take their teams to the large lumber camps.

Potatoes and grass are grown on nearly all the soils, except the swamp lands, but it is a generally recognized fact that while the black soils are especially well suited to grass, they are not so well adapted to potato production. It is also claimed that the river soils are the best grass lands in the area, and that potatoes do better on the hardwood ridges.

No single system of crop rotation is followed. The general practice is to have a three-course rotation involving three, four, five, or six years. With this end in view three general systems have developed, as follows: (1) Potatoes two years, grain one year, grass two years; (2) potatoes one year, grain one year, grass two or three years; (3) potatoes one year, grain one year, clover one year. Each of these systems has its advantages. While a smaller yield of potatoes is apt to result from the use of the first system, many farmers have resorted to it in order to kill out the couch grass. The first and second systems have a distinct advantage over the last where it is intended to sell large quantities of hay. There is not much demand for clover hay in the Boston market, and as very little timothy can be secured the first year from seeding, it is necessary to leave

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the land in grass two or three years. The third system and least used should be the one most generally followed. In order to do this successfully, since, as has been stated, there is not much demand for clover hay outside of the local markets, the farmers should keep more sheep and dairy cattle and feed the greater part of the crop on the farm.

The farmers all claim, however, that there is more money in potato production than in dairying, and practice the other rotations for this reason. There is no apparent necessity for any decrease in the acreage annually devoted to potatoes where dairying is followed, as the two industries need not interfere with each other. Under such a system of farming the fertilizer bill could be greatly decreased, for with the large amounts of stable manure used as a top dressing and by plowing under the aftermath that always springs up where a crop of clover is removed, the productivity of the land would continually increase, and the same production of potatoes could be secured from much smaller areas.

Another distinct advantage this system has over the others is that the farmers would not be so entirely dependent on the potato crop, and in years of poor crops, which are bound to come occasionally, they at least would have the income from the dairy.

The absence of bowlders and the rolling though not hilly topography makes possible the use of all kinds of farm machinery, such as diggers, planters, mowers, hay loaders, and manure spreaders. The preparation of the land is deep and thorough, the two-horse sulky plow being used in most cases, although some farmers still use the walking plow. After plowing in the fall the small stones are picked up and thrown into heaps or used for filling swampy holes.

In clearing new land the trees are cut and the timber removed during the winter, and the following spring the brush is burned and the land plowed and seeded to clover and timothy. It is then left from two to five years, being used largely as pasture, although some farmers cut the grass with a scythe. At the end of this time the stumps have rotted sufficiently so that the smaller ones can be pulled by horse power, while the larger ones are blown out with dynamite. The land is then planted to potatoes. The cost of clearing land in this way varies from $10 to $15 an acre, and can usually be paid for by the returns from the timber removed. It is generally estimated that on the hardwood ridges there is from 1,000 to 2,000 feet per acre of spruce, which is the most valuable timber. In addition there is a ready market for a limited amount of the beech and birch for firewood, and some of the mills use large quantities for various purposes.

Commercial fertilizers are applied only to the potato fields, and large amounts are used on this crop. Very little attention is given to

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stable manure, and by the time it reaches the field it has lost much of its strength as a fertilizer. Thus the productivity of the soil depends almost entirely upon the use of commercial fertilizers. It is claimed, however, that under this treatment the productivity of the land has gradually increased, but whether this will continue indefinitely or not is an unsolved problem.

As a rule little difficulty is experienced in securing efficient labor when needed. By the use of all kinds of farm machinery the farmers with large families have need of little hired help, except during the potato-harvesting season, when large numbers of laborers come in from the Provinces. The average wage paid at these times ranges from $2 to $2.50 a day with board. By the month laborers command from $20 to $30 with board.

According to the census of 1900 the average size of farms was 114.3 acres, and 91.7 per cent of these were operated by the owners, the remainder being rented. On the rented farms the share and cash tenants are about evenly divided. Where land is rented on shares the owner and tenant each receive one-half the crop. Cash rents run from $10 to $25 an acre, depending on the nearness to market and the condition of the farm.

The value of farm lands has tripled in the last twelve or fifteen years, and instances are not uncommon where farms have sold for ten times what they brought twelve years ago. The greater part of the cleared ridge land, with improvements, sells for about $100 an acre.

It is recommended that better care be taken of the stable manure. If it were kept under cover until hauled to the field, and if the straw and rubbish, instead of being burned, as is commonly done, were incorporated with the manure, the fertilizing value of the manure would be greatly increased. The adoption of a three-year rotation and the keeping of more live stock would doubtless prove a very satisfactory system of farming. Under such a plan the fertilizer bill could be greatly reduced. This could also be accomplished to a certain extent if the home mixture of fertilizers were more generally practiced.

THE POTATO INDUSTRY.

The crop of paramount importance in this area, and the one to which more and more attention is being given, is the potato. From a very small beginning, when the first settlers planted a few for home consumption, the production has increased until in 1908, after a lapse of a period of eighty years, the estimated crop of the county is 16,000,000 bushels, a large proportion of which was produced in the area surveyed. As has been stated, the introduction of the starch factory gave the first great impetus to this industry. This brought the farmers to a realization of the fact that large yields of an excellent quality were obtainable. The small shipments at first

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made gradually increased, and with the opening up of a direct railroad line in 1894 the acreage in potatoes was rapidly extended.

The prominence of this area as a potato section is due to the fact that the farmers have taken advantage of natural conditions and improved the opportunities for growing this particular crop. Here the soil in every way is especially suited to potatoes. It consists of a hazel-brown silty loam containing many small fragments of shale and other rocks. At a depth of 3 to 6 feet this is underlain by a calcareous shale which has been mingled more or less with the other soil material. The soil has excellent underdrainage, so the crop seldom suffers from an excess of moisture, while on the other hand it will stand a long period of dry weather with little if any injury to the crop. Furthermore, the climate is conducive to a quick and healthy growth of the crop; but with everything that is desirable in the way of soil, drainage, and climate it would be impossible to produce large crops unless properly managed, and the farmers as a rule practice up-to-date methods in cultivation, harvesting, and handling of the crop. No systematic rotation is closely adhered to, but the general plan is as follows: Potatoes, one or two years; grain, usually oats, one year; and grass, one, two, or three years. Owing to the short growing season it is essential that the land be plowed in the fall in order that planting may be done at the first opportunity in the spring. On account of the deep covering of snow there is little if any frost in the ground, so it is possible to start farm work almost as soon as the snow melts in the spring. The land is then harrowed two or three times with a spring-tooth harrow. The potatoes are planted as soon as the weather will permit, which is usually about the 10th of May, with some improved type of planter. They are always planted in drills 2 feet 10 inches apart, the seed being 1 foot apart in the drill. Even with the most thorough preparation of the land the yield from machine-planted fields is from one-fourth to one-third less than the same field planted by hand. This is due to the number of skips caused by the failure of the seed to sprout for one reason or another. However, where large areas are planted hand work is not practicable. For seed the potatoes are nearly always cut, the rate of seeding being from 4 to 5 barrels per acre. The varieties planted vary with the section, but the three most generally grown are the Green Mountain, Red Bliss, and Irish Cobbler.

Large amounts of high-grade fertilizers are used, the applications ranging from 1,200 to 1,500 pounds per acre. Special mixtures of fertilizers are used, 4–6–10,[a] 5–7–10, and 6–8–10 being the usual formulas. The entire amount is applied at the time of planting, although experiments have shown that the yield can be increased by

[a] In this and the following formulas the ingredients are given in the order N, P_2O_5, and K_2O.

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applying a part of this fertilizer at the time of planting and the remainder at the first two cultivations. Home-mixed fertilizers are never used, as the farmers claim that they have not the time to do the mixing and that there is frequently difficulty in securing the ingredients.

Very little account is taken of stable manure for the potato crop. It is very important where manure is used that it be applied as a top dressing to the grass land after the hay crop has been removed, as it is almost certain to produce rot if used directly on the potato land. If the land becomes too weedy before the potato sprouts appear above ground a weeder is used. As soon as the plant breaks through the surface the double-shovel plow is brought into use. This throws the dirt over the young plants, covering them to a depth of 1 inch, thus protecting them against late frosts and at the same time killing the weeds. After this the crop receives three or four cultivations with a walking or riding cultivator, and immediately following such cultivations the land is gone over with a double-shovel plow, throwing the soil in ridges around the plants. Level cultivation has been tried with success, but most of the farmers claim that diggers will not do satisfactory work unless the potatoes are ridged.

The only weed that gives any trouble is couch grass. In dry seasons this weed bothers very little, but in wet seasons persistent and judicious cultivation is required to keep it down.

As is the case in most other sections, the greatest problem that the farmers have to contend with in growing the potato is the blight, which, unless kept in check, greatly reduces the yield. As a rule, however, the farmers are able to control the disease, and almost all the growers spray the vines. Bordeaux mixture is used, the usual formula being 5 pounds of lime and 5 pounds of copper sulphate to 50 gallons of water. The solution is put on with a power sprayer which covers six rows at a time and is applied every two or three weeks until the tops stop growing. About 50 gallons is required for an acre. Some of the smaller farmers still use the barrel spray hauled by horse and worked by manual labor. As a rule the Colorado beetle does not give much trouble, but when they do appear they are killed by mixing 2½ pounds of Paris green to 2 barrels of Bordeaux. Many farmers apply the Paris green in powder form with a blower, but the method first mentioned is more satisfactory and at the same time saves considerable labor.

The harvesting of the early varieties begins as soon as the potatoes have attained a marketable size, which is usually about the 20th of August, and continues with the later varieties through September and well into October. All the digging is done with a mechanical digger drawn by two or three horses. With this machine from 4 to 6 acres can be dug in a day and from 8 to 16 hands are required to pick up.

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The cost of producing a barrel of potatoes varies from 55 to 75 cents. The yield of course depends somewhat on the soil, but the average is probably about 75 to 85 barrels per acre. In good years, however, 100 to 125 barrels is not an uncommon yield on the better farms, while 150 and 160 barrels are frequently reported.

A part of the crop is sold directly from the field, but at the time of harvesting many of the farmers are too busy to haul their potatoes to market, so they have constructed potato cellars in which the greater part of the late crop is stored. These cellars are made with cement walls; only the roof is above ground and special attention is given to ventilation. The potatoes may be kept here without danger of freezing except in the coldest weather, when small fires are built. Later in the season, when the fall work is done, the potatoes are carted to the towns, where they are sold to buyers who ship them directly or else store them in the large warehouses with which each town is supplied. Taken together, these storehouses hold thousands of bushels, and here the crop is held and distributed whenever and wherever the dealer sees fit. Through the introduction of the Eastman heater car it has become possible to ship potatoes even in the coldest weather without danger of freezing. These dealers buy only the merchantable tubers which are sold for table use or for seed purposes. The former comprise by far the larger proportion of the crop. The price ranges from $1 to $2 a barrel, depending on the quality of the crop and the supply in other sections.

The production of potatoes for seed purposes is quite an important industry in some sections of the area, and each year a number of buyers from Virginia, the Carolinas, New Jersey, Long Island, and other potato-growing sections to the south come here to obtain seed stock. Many of the farmers grow potatoes with this end in view and sell direct to these buyers. In many cases the dealers contract with the farmers to raise a certain number of barrels at a stated price, the dealers often furnishing the seed for the crop in order to keep it pure. The price obtained for these potatoes is about the same as for table potatoes.

All the unmerchantable and, in times when the market price is exceptionally low, many of the merchantable tubers are disposed of at the starch factories, of which there are a large number operating in the area. The average capacity of a factory is 75,000 bushels during the usual working season, which is from the middle of September to the middle of November. On the average, 200 bushels of potatoes make a ton of starch. The process is quite simple. The factories are located on a clear stream of water and consist of storehouses, a building with steam power machinery for washing and grating the potatoes, and a building for drying. The potatoes are washed thoroughly, then grated, the pulp falling on large wire sieves.

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Clear water is turned on and washes the starch out of the pulp, carrying it through the sieve into a large vat. When the vat is full of water holding starch in solution, it is allowed to stand twenty-four hours, when the starch has settled to the bottom. Only a portion of the starch is clear. This clear starch is removed, while the residue undergoes a second washing. After two or three washings the starch is taken to the drying house, where it is dried by means of steam pipes. It is then barreled and sold to cotton manufactories, where it is used in the manufacture of cotton cloth. The average price paid for the potatoes that are convertible into starch is 40 to 50 cents a barrel.

SOILS.

During the Glacial epoch all of Maine was covered with a slowly moving sheet of ice of great thickness. This mass, by crushing and grinding, rounded off the ridges and filled in the valleys with transported material. As the ice melted it left an unassorted mass of coarse and fine material over the entire region. The lower till, or that carried beneath the ice, remains as a very compact grayish silty layer containing many rounded stones in great variety, with some coarse gravel and shale fragments. Resting upon this is a stratum which was carried upon and within the ice sheet, and this is known as the upper till. This in places contains a large number of small, rounded stones, while in others it is comparatively free from them. It is much darker in color and more friable than the lower till, the difference probably having been brought about by differences in degree of oxidation and by the greater amounts of organic matter in the upper till, as a result of the growth and decay of plants. The depth of the upper till varies from 1 to 3 feet, although in a few cases it is apparently absent. At the close of the Glacial epoch the land is believed to have subsided, and the climate to have become warmer. At this time the Aroostook Valley was partly filled and swift flowing streams laid down the second terraces. Then followed an elevation of the country and the stream continued cutting its channel until the present level was reached, where the first bottoms or last terraces are still in the process of formation. These two terraces are the only ones that show along the Aroostook River.

The soils in Aroostook County are thus of glacial origin, being derived from glacial débris as originally deposited or from similar material modified to some extent by water agencies. Since deposition these soils have undergone some very important changes through the influence of weathering and as a result of the growth and decay of plants. These processes have in most cases changed the surface 1 or 2 feet from a compact gray soil to a friable yellow loam.

Unlike most glacial soils, these soils give evidence of having been transported but a short distance and have in most cases been derived

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from the underlying rock or from a similar rock a short distance to the north. The rock from which the most of these soils are derived is the shaly Aroostook limestone. This rock is found at depths ranging from a few inches to 25 or 30 feet, the average being from 2 to 6 feet, although small areas of outcrop are frequently encountered. There are, however, small bodies in the Aroostook volcanic area, underlain by other rocks of which small outcrops also occur. Such rocks are the conglomerate and diabase of Mars Hill, the Mapleton conglomerates, sandstones, and granites; the Chapman sandstones; the trachytes of Edmund and Hobart Hill; and the quartz-trachytes of the Quaggy Joe region. Of these the only ones that have influenced the character of the soil to any noticeable degree are the sandstones and conglomerate, which, where they are near the surface, not only change the texture but also the color of the overlying material. In addition, there is a small area in Chapman and Mapleton townships underlain by arenaceous limestones, a belt of which extends nearly north and south just outside and to the west of the area. The area as a whole is remarkably free from large glacial bowlders, although occasionally one may be found in any part of the survey, while in the immediate vicinity where outcroppings occur bowlders are very abundant.

Twelve distinct soil types have been recognized and mapped in the area. According to topography, these may be divided into two general groups—those derived from unmodified drift, or upland soils, and those derived from modified drift, or lowland soils. Of the latter four types were recognized. The other and the most important group includes all the other soils. When classified according to origin, the soils fall into three groups—alluvial soils, including those which are at present in the process of formation and those formed before the river had cut its present level; glacial soils, representing the sheet of unmodified drift which covers the greater part of the area; and, finally, the organic soils, which have resulted from the accumulation and decay of plants and trees. In most cases these groups have been subdivided into classes, such as silts, loams, silt loams, and sandy loams, according to their texture as determined by mechanical analyses of typical samples. These classes have further been divided into types and grouped in series where the similarity in origin, color, topography, and agricultural value was sufficient to warrant such a grouping.

Following such a plan, those soils derived from unmodified glacial drift have been separated into eight distinct types. The similarity in four of these types was sufficient to warrant the grouping of them in the Caribou series. These are the Caribou loam, Caribou stony loam, Caribou gravelly loam, and Caribou silt loam. The other four types—Easton loam, Mapleton gravelly loam, Washburn loam, and Chapman loam—were placed in separate series.

Those soils derived from modified glacial drift have been separated into three types representing the Aroostook series. These are Aroos-

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took silt loam, Aroostook sandy loam, and Aroostook loam. Of these the Aroostook silt loam is the most important type. None of them, however, cover any great area.

Under the organic soils there is one type—Muck. This type has resulted from the decay of vegetable matter which has become mixed with soil washed in from adjacent slopes.

The larger number of these types are very productive, and with the exception of the Caribou stony loam and Muck areas admit of the use of any kind of labor-saving machinery.

The following table gives the actual and relative extent of each of the soil types:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Caribou loam	220,672	65.1	Caribou stony loam	3,328	1.0
Muck	55,296	16.3	Aroostook silt loam	2,432	.7
Chapman loam	27,648	8.1	Aroostook sandy loam	960	.3
Caribou silt loam	10,176	3.0	Mapleton gravelly loam	192	.1
Easton loam	9,024	2.6	Aroostook loam	64	.1
Washburn loam	5,504	1.6			
Caribou gravelly loam	3,904	1.1	Total	339,200	.....

CARIBOU LOAM.

The Caribou loam, to an average depth of 10 inches, consists of a hazel-brown silty loam. Beneath this is a yellow silty loam of about the same texture, which ranges in thickness from a few inches to 2 feet, where it rests on the gray or grayish-yellow silty loam of the lower till. In places this lower till comes within a few inches of the surface, in which case the yellow stratum is lacking. Small rounded stones, consisting of sandstone, gneiss, granite, and quartzite, are found in both the soil and subsoil, but are more numerous in the latter. In many cases, especially in the northern part of the area, these stones are so numerous that it is impossible to bore to depths greater than 15 to 20 inches. Along many of the stream slopes small stones are so abundant as to give the soil the appearance of a gravelly loam, although the texture of the interstitial material is little different from the rest of the type. Almost the entire type is underlain at a depth ranging from a few inches to several feet by a calcareous shale, many small fragments of which are distributed throughout the soil and subsoil. These fragments are especially numerous in the southern part of the area, where the rock as a rule is somewhat nearer the surface. Small outcropping areas of these rocks have been designated on the map by symbol. In virgin forests there is usually a thin layer of a white floury silt just beneath the covering of the leaf mold.

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As mapped the type includes many small depressions of Easton loam and Washburn loam. That part of the type along the slopes of the northern half of Mars Hill is somewhat darker in color and contains more moisture. A freshly plowed field of Caribou loam presents a mottled appearance, showing white, brown, and black areas.

As a rule the soil is friable, free from large bowlders, well drained, and seldom bakes, thus rendering the use of all kinds of improved farm machinery both easy and profitable.

The Caribou loam occurs in all parts of the area as practically one continuous body, dissected by strips and small areas of other types. In the low country around Mars Hill it gives way to the Caribou silt loam, a similar soil in every respect, though containing about 10 per cent more silt. The townships containing the greatest proportion and the most typical bodies of the type are Limestone, Presque Isle, Easton, Fort Fairfield, and Caribou.

This is an upland type occupying the swells and ridges and extending down the stream slopes nearly or quite to the streams. Its position insures good surface drainage, while the compactness of the subsoil aids in making the soil retentive of moisture. The type withstands long dry periods to a remarkable degree.

The Caribou loam is glacial in origin, having been derived from unmodified drift. The soil gives evidence of having been transported but a short distance and has originated from the underlying Aroostook limestone. The upper bright-yellow layer is that part borne in and on the ice, while the grayish compact material was carried beneath the ice.

The native vegetation consists of hardwoods, as maple, ash, yellow birch, and beech, with a scattering growth of spruce and fir. At one time white pine abounded on this type, but this has long since disappeared.

All farm crops do well on this soil, and it produces by far the greater part of the potatoes grown in the area. It seems especially adapted to potatoes, and to grass and all kinds of grain, vegetables, and fruits. The yield of potatoes depends on the variety grown and the attention given the crop. The average probably runs from 80 to 85 barrels. In good years, however, as many as 150 barrels per acre have been reported, while 100 barrels is not at all uncommon. Hay yields from 1 to 1½ tons, oats 50 bushels, wheat 25 to 30 bushels, and barley 40 to 50 bushels per acre.

Cultural methods do not differ from those given other soils. The rotation is potatoes one or two years; oats one year; grass one, two, or three years. If this rotation were shortened and more stock kept, the soil could be improved and the fertilizer bill reduced. The fertilizer application is 1,200 to 1,500 pounds per acre.

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The best farms in the area are located on the Caribou loam. The greater part of the type is under cultivation and the remainder is being rapidly cleared. Timbered areas sell for $12 to $15, while the cultivated land brings from $75 to $100 an acre with improvements, the price depending somewhat on nearness to market.

Average results of mechanical analyses of fine-earth samples of soil and subsoil are given in the following table:

Mechanical analyses of Caribou loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19608, 19609, 19611...	Soil.....	3.0	8.5	4.6	11.0	10.0	50.9	16.5
19609, 19610, 19612...	Subsoil....	4.2	8.9	4.1	10.0	9.4	46.9	16.8

CARIBOU SILT LOAM.

The Caribou silt loam consists of 10 inches of a yellowish-brown to hazel-brown silt loam, underlain by a brighter yellow silty loam which may continue throughout the limits of the soil profile or else pass into the grayish silty loam of the lower till in the lower depths. This in turn is underlain at depths ranging from 1 to several feet by a calcareous shale. Many small shale fragments and a few small stones are found in both soil and subsoil, but the latter are much less abundant than in the other soils of the area. Unlike the condition in the other soil types, nearly all of the stones in the silt loam subsoil are fragments of Aroostook limestone. Similar fragments occur in the surface soil, but there are also a few fragments of foreign origin. The type is so similar to and changes into the Caribou loam so gradually that at times the separation of these types becomes very difficult. The Caribou silt loam, however, contains fewer stones and runs a little higher in silt content. As the type is well drained and contains comparatively few stones, it is very easily cultivated.

The type occurs in four bodies, ranging in size from one-fourth to several square miles in extent, in the townships of Easton, Mars Hill, Blaine, and Bridgewater. The largest body is found in that part of the valley of the Prestile Stream and its branches lying between the villages of Mars Hill and Bridgewater Center. It occurs on ridges, slopes, and as flat areas. The elevation as a whole is somewhat less than that of the Caribou loam.

At present practically all of the type is under cultivation. The virgin forests consisted of such hardwoods as beech, yellow birch, and maple, with a sprinkling of spruce and fir.

Like the Caribou loam, this soil is noted for the yield and quality of its potatoes. The yields range from 75 to 85 barrels, although in exceptional cases as high as 140 barrels per acre may be secured.

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Grass, grain, fruit, and vegetables do well. Hay yields from 1 to 1½ tons and oats about 50 bushels. The cultural methods do not differ from those employed on other types, and the fertilizer application is about 1,200 to 1,500 pounds to the acre.

As most of the type is conveniently located as to markets, the land with improvements sells on the average for about $100 an acre.

The following table gives the average results of mechanical analyses of fine-earth samples of the soil and subsoil:

Mechanical analyses of Caribou silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19620, 19619	Soil	2.8	6.7	2.7	6.3	8.5	52.4	20.9
19621, 19620	Subsoil	3.4	7.5	2.6	6.4	12.2	46.4	21.3

CARIBOU STONY LOAM.

In its typical development the Caribou stony loam consists of 8 inches of a yellowish-brown silty loam, underlain by a yellowish-gray silty loam which persists throughout the limits of the soil profile or until the underlying rock is encountered. That part of the type found on Mars Hill is somewhat more gravelly than the typical soil and has a reddish cast. Small areas of a similar soil were also encountered on Hobart Hill. On Green Mountain the soil consists of a shallow mantle of the yellow till, covered by a deep vegetable mold and underlain by quartz-trachyte. As mapped, the type includes small rock outcrop areas of conglomerates and diabase on Mars Hill, andesite on Hobart and Edmund hills, and of quartz-trachyte on Quaggy Joe and Green Mountain. In all cases the slopes are strewn with large glacial bowlders of granite, gneiss, trachyte, andesite, and conglomerates. Because of the large number of glacial bowlders, the shallowness of the soil, and the steep slopes, the type is rather difficult to cultivate.

The Caribou stony loam is found in bodies varying in size from a few acres to 1 square mile or more, and is confined entirely to that part of the survey south of Presque Isle in what is known as the Aroostook volcanic area. The largest area, 2½ miles long by 1 mile wide, is just east of Mars Hill village and comprises the greater portion of the hill of that name. The next most important area occurs as a narrow belt along the range of mountains, of which Quaggy Joe and Green Mountain are the most important peaks. This body is about one-fourth mile wide and extends in a nearly north and south direction for 3 miles. In addition there is a smaller area on Hobart Hill in Chapman and Mapleton townships and one in the western part of Bridgewater. All other areas mapped are of minor importance.

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As the type, without exception, occupies high ridges, peaks, and steep slopes, the drainage is very thorough and would probably be excessive if the forest growth were removed.

The Caribou stony loam is derived from glacial till, but in some cases has since been changed by the decomposition of the underlying rock or by accumulations of organic matter. The characteristic forest growth consists of yellow birch, beech, and maple, with a sprinkling of spruce and fir.

None of the type is under cultivation. While the glacial bowlders might easily be removed from most of the area, yet owing to the shallowness of the soil and steepness of the slopes, it is best that they remain in forest as at present or else be used for pasturage.

The value of the Caribou stony loam depends almost entirely on the timber growth and ranges from $2 to $8 an acre.

CARIBOU GRAVELLY LOAM.

The soil of the Caribou gravelly loam consists of a gravelly loam containing a high percentage of silt and varying in color from a yellowish brown to a dark-chocolate brown, being much darker when wet than when dry. At 10 inches this grades into a bright yellow gravelly loam containing somewhat more gravel and small stones than the soil. Underlying this at a depth of about 20 inches there is usually a dark-colored coarse gravel, although in a few cases there is a compact yellowish-gray gravelly loam, which corresponds to the lower till of the Caribou loam, overlying the gravel. Sectional exposures show this dark gravel stratum to vary in depth from 1 to 3 feet, beneath which are several distinct though somewhat irregular strata of coarse sand, gravelly sand, and medium sand. Both soil and subsoil contain from 40 to 50 per cent of rounded and angular glacial gravel from one-fourth of an inch to 4 inches in diameter.

A freshly plowed field has a decidedly mottled appearance, having small patches of blackish and whitish soil mingled with the various shades of brown and yellow as the predominating colors. The soil is very mellow, and although there are many small stones only a few are large enough to offer any resistance to the plow or cultivator.

The Caribou gravelly loam is found in all parts of the area in bodies varying in size from 1 acre up to 1 square mile, the largest occurring on the east and southwest slopes of Mars Hill. Usually the type occurs as morainal knolls or as larger bodies in which the morainal knolls are a prominent feature. It is, however, necessary to make some exceptions to this general rule, as the largest body mapped, namely, the area at the east foot of Mars Hill, is conspicuously devoid of these hummocks. Frequently small areas are found along the streams, but the type is of more general occurrence in the larger bodies of the Caribou loam. Many small knolls of the gravelly loam

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are included in the Caribou loam, as they are too small to be mapped separately.

On account of the loose, porous nature of the soil and subsoil one would expect the crops grown to suffer from drought, but although the type does not withstand long dry periods as well as the more retentive soils the crops are seldom injured by lack of moisture.

The Caribou gravelly loam is of glacial origin, and though the underlying gravel shows the effect of swift-flowing waters the surface soil indicates little if any such effect, with the possible exception that some of the finer material was carried by waters from the melting ice.

Practically all of the type is under cultivation. The characteristic timber growth consists of beech, birch, and maple, with some scattered spruce, fir, and cedar. All these have replaced the white pine with which this country was once forested.

The Caribou gravelly loam is well suited to potatoes, the yield varying from 70 to 90 barrels per acre. Grass, buckwheat, and oats do fairly well, but usually show the effects of too thorough drainage. As a whole the type is better suited to potatoes than to any other crop. The soil requires somewhat larger applications of fertilizers than the Caribou loam in order to maintain its productivity. Like all other soils of a porous nature, it is very probable that the Caribou gravelly loam would be greatly benefited by heavy applications of barnyard manure.

The value of this type is dependent on the nearness to market, but as a rule it sells for $90 to $100 an acre with the improvements.

The results of mechanical analyses of typical fine-earth samples of soil and subsoil are given in the following table:

Mechanical analyses of Caribou gravelly loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19615	Soil	7.5	11.5	4.4	8.3	8.4	43.1	16.5
19616	Subsoil	9.6	20.9	6.6	10.5	7.8	29.4	14.4

Sample No. 19615 contained 52.1 per cent of coarse gravel, and No. 19616, 72.3 per cent.

MAPLETON GRAVELLY LOAM.

The soil of the Mapleton gravelly loam is a rather coarse gravelly loam 12 inches or less in depth and containing a rather high percentage of silt. When wet the soil is a very dark brown with a reddish cast, but when dry it becomes a purplish color. Below 12 inches it is a reddish-yellow gravelly loam of uniform texture throughout the soil profile. As a rule, the rock is encountered anywhere from 6 to 20 inches below the surface, while in some cases small outcrops occur.

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The gravelly material in both soil and subsoil consists of angular and waterworn fragments of sandstone and quartz.

The Mapleton gravelly loam is of very limited extent. Only four bodies were mapped, their combined area being less than one-half square mile. With the exception of one small body in Presque Isle Township, near Spragueville, all the type is confined to the northeast corner of Mapleton Township, occurring as long, narrow ridges on what is known as Creasy Ridge. These ridges, which mark places where the underlying conglomerates come near the surface, in many instances are only a few feet wide. As it was impossible to show the smaller areas on the map, they were included with the Caribou loam. Since the type occupies ridges and slopes, and is of a loose texture, it is usually well drained. Except in those cases where the rock is exposed or else covered with a thin layer of soil, there is nothing to interfere with cultivation.

The Mapleton gravelly loam, partly glacial and partly residual in origin, owes its present characteristics to the underlying red conglomerates and sandstones, from which it has been derived through glacial and weathering agencies. It is undoubtedly true that at one time some of these areas consisted of the same soil as the Caribou loam, but through the decomposition of the coarse conglomerates, where near the surface, the original texture and color of the soil have undergone a decided change, while, as a result of the breaking down of the conglomerate rock, the type has become a gravelly loam.

The native vegetation consisted principally of such hardwoods as beech, birch, and maple. At present, however, all the type is cleared and under cultivation. Potatoes, grass, and grain are grown, and where the soil covering is not too shallow very good yields are secured, although perhaps not quite equal to those on the Caribou loam. This soil seems to be well adapted to fruits, and especially apples. The fertilizer applications are the same as for all the other soils in the area.

No areas made up exclusively of this type are on the market. Its value is largely determined by the value of surrounding bodies of the Caribou loam.

Results of mechanical analyses of fine-earth samples of the soil and subsoil are given in the following table:

Mechanical analyses of Mapleton gravelly loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19625	Soil	9.6	25.0	8.2	12.9	11.7	15.2	18.2
19626	Subsoil	11.2	16.9	5.7	9.1	12.6	13.4	13.2

Sample No. 19625 contained 46.7 per cent of coarse gravel and No. 19626, 52.0 per cent.

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EASTON LOAM.

The Easton loam consists of 10 inches of ashy-gray or nearly white silty loam, underlain by a mottled gray and yellow silty loam or silt loam in which there is a gradually increasing amount of yellow soil until at 36 inches only slight mottlings of the gray material are discernible. Very frequently a layer of sticky yellow clay is encountered at 20 to 30 inches. As a rule, both soil and subsoil contain a large number of angular glacial bowlders and rock fragments up to 1 foot in diameter, seldom larger, and a noticeable quantity of fine sandstone and shale gravel. When very dry the surface has a whitish appearance and a floury texture, indicating the presence of a large proportion of "rock flour," the result of the grinding up of the rocks by glacial action. The rock and shale fragments have a white coating which, in the newly plowed field, increases the whitish appearance of the soil.

In its natural state the type has a thin coating of leaf mold, but under cultivation this becomes incorporated with the white soil and in a short while all traces of it disappear. On account of the poor drainage and stiff nature of the type it is a rather difficult soil to handle until artificially drained.

The Easton loam occurs in bodies of varying sizes, from a fraction of an acre up to three-fourths of a square mile in extent, the largest being found in the northern part of the area in the townships of Caribou, Presque Isle, and Limestone. Only a few areas large enough to map were found south of Easton and Presque Isle townships. The type occurs as flat or depressed areas in larger bodies of Caribou loam and presents a very marked contrast to the dark-brown color of the latter type. Not infrequently it occurs as narrow strips bordering larger areas of muck. Because of its position the soil is inclined to be poorly drained and good crops can not, as a rule, be grown until artificial drainage has been established.

The Easton loam is of glacial origin and owes its strikingly light color either to a less advanced stage of weathering or to an alteration of the upper till. It is possible that these areas may have been covered by water or may have been subject to wet and dry stages, conditions hindering oxidation by preventing aeration.

The characteristic native vegetation consists of a thick growth of small tamarack, spruce, fir, cedar, poplar, and white birch. Where the growth is not too thick there is a heavy covering of moss over the soil. Old pine stumps are frequently encountered, showing that this most valuable tree at one time grew on this soil.

When properly drained fair yields of potatoes are secured, although nothing like the yields obtained on adjoining areas of the Caribou loam. There is some difficulty in securing a good stand, as the soil is inclined to be cold and wet, conditions which prevent or

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hinder the sprouting of the tubers. Potatoes produced on this soil are somewhat inferior in quality, as there is a tendency toward scabbiness. Oats and grass do fairly well, although the latter is inclined to winterkill.

What this soil needs is a thorough system of drainage. This, together with the incorporation of organic matter in the form of barnyard manure, would improve the texture of the soil and increase the productivity. The fertilizer application is about the same as that for other soils of the area.

The agricultural value of this individual soil type can not be given, as it is always included in larger areas of the Caribou loam and other types.

Results of mechanical analyses of fine-earth samples of the soil and subsoil are given in the following table:

Mechanical analyses of Easton loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19621	Soil	6.0	9.5	4.0	11.3	9.0	40.8	19.4
19622	Subsoil	6.3	10.6	4.9	14.7	14.5	35.3	13.7

CHAPMAN LOAM.

The Chapman loam is an extremely variable soil, and no general characteristics of texture and color hold for the entire type. For this reason it is necessary to consider the different phases separately. The type as a whole has a very hummocky surface, the hummocks being 4 or 5 feet in diameter and a foot or two above the intervening depressions. For the most part the soil of these hummocks consists of a bright-yellow to brown, rather coarse loam, sometimes gravelly, and frequently containing pockets of fine white silt or medium-textured dark-colored sand. At or about 12 inches this gives place to a sticky loam, somewhat lighter in color and containing appreciable amounts of clay. The subsoil becomes heavier with depth, until at 24 to 30 inches it grades into the compact silt loam or silty loam of the lower till. In some places this phase grades into a bright-yellow silt loam, in which there is enough clay to make the soil decidedly sticky. On other mounds the unweathered white or light-gray till is found at the surface; while in still other cases the soil may consist of a light-gray or yellowish-gray silty loam mottled with brown iron stains. This phase usually contains considerable clay, and it is because of this characteristic that the different phases of the type have received the local name "clayey lands."

In the hollows the type may consist of a grayish silt loam, similar to the lower till, covered with 6 to 8 inches of vegetable mold or muck,

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or it may be merely a mass of rock, while as a rule few stones are encountered in the hummocks. All these phases were frequently found in an area of 200 square feet, but in all cases they were underlain by the grayish-white silty loam or silt loam of the lower till.

The type as mapped includes many bodies and strips of Muck, some of which were too small to outline and others it was impossible to locate because of the dense forest. A field of this type plowed for the first time shows the various shades of yellow, white, greenish-gray, and black, and usually contains some small angular bowlders. When the stumps and stones have been removed the soil is easily cultivated, although in wet seasons it is more difficult to handle than the Caribou loam because of its sticky nature.

The areas of the Chapman loam range from a few acres to several square miles in extent. They are found in every township included in the survey, but the largest occurs in the northwest corner of Limestone, and also another large body in the northeast corner of this same township. Both of these are termed "blueberry bogs," from the fact that they support a growth of blueberry bushes. Other large bodies are found in the eastern part of Chapman, the southeastern corner of Mapleton, and along the Easton-Fort Fairfield line. In addition to these, there are many smaller bodies scattered throughout the area. As a rule, the larger bodies of the type occupy a low plain country at the source of several streams or along stream courses. Some of the smaller areas, however, have a more sloping topography. That part of the type occurring as plains is inclined to be poorly drained.

The Chapman loam is of glacial origin, but its original characteristics have been changed through the influence of several agencies. The hummocky surface has probably been produced in three ways: First, by the upturning of trees, leaving mounds of dirt; second, by burning out of old stumps, leaving depressions; third, by heaving of the soil through the action of frosts.

The native forest growth, which in many cases is still standing, consists of spruce, fir, cedar, tamarack, white birch, poplar, and alder, with a sprinkling of other hardwoods. The vegetation on those areas known as "blueberry bogs" consists of blueberry bushes, alders, dwarf cornel, and moss, while many of the hummocks are bare. This difference is undoubtedly due to the fact that every year or two the bogs are burned over to increase the yield of the blueberries, of which thousands of bushels are sold each season.

On account of the cold, wet nature of the soil and the hummocky topography, the greater part of the type is still uncultivated. When once cleared, however, the better drained portions produce fair yields of grass and grain but are not so well suited to potatoes. Other areas will require artificial drainage before crops can be successfully grown.

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The value of the type depends on the timber growth and the nearness to market. Where the growth is light from $6 to $10 an acre is the usual price, but where there is a good stand of spruce and fir on areas near the railroad the value may run as high as $25 an acre.

Because of the variability of the type no samples were taken for mechanical analyses.

AROOSTOOK SILT LOAM.

The Aroostook silt loam to a depth of about 10 inches is a dark-brown friable silt loam. Beneath this there is found a lighter brown silt loam, slightly mottled with gray and chocolate brown, which usually becomes sandier as the depth increases. The sandy material is underlain at 3 to 5 feet by a stratum of dark-colored gravel. When wet, the surface soil has a very dark appearance, but the dry surface becomes grayish. The soil in slight depressions is a heavy silt loam, underlain by a mottled gray and yellow silt loam, the proportion of gray color increasing with depth until at 36 inches the color becomes nearly solid gray, slightly mottled with brown. In the higher lying areas and near the river the soil contains a greater percentage of fine sand. Pockets and thin strata of fine sand are not infrequently found in the subsoil, while small mica flakes occur in both soil and subsoil.

A phase which occurs to a limited extent along Presque Isle Stream is darker in color and has a slightly higher content of silt and clay.

The soil as a whole being very mellow, free from stones, and, with the exception of the phase just described, well drained, presents no obstacles to the plow or cultivator.

Excepting a small area of a few acres found along the Prestile Stream just as it leaves the county and some narrow bodies along the Presque Isle Stream just west of the village, all the Aroostook silt loam mapped occurs along the Aroostook River. Narrow strips are found on one or both sides of the river along the greater part of its course through the area, but there are frequent breaks where high bluffs rise directly from the stream bed. The largest bodies, however, occupy a chain of islands extending from a point in the river directly north of Presque Isle to a point about 1½ miles east of Crouseville. The smallest of these covers only a few acres, while the largest comprises nearly one-half square mile. These islands are really a part of the first bottoms of the river, but have been separated from adjoining bodies of land by the cutting of new channels in times of high water. At all other times the water moves very slowly through these old channels.

Without exception the type occupies the first bottoms, which are from 8 to 10 feet higher than the river. The surface is flat or gently

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undulating and, being underlain by gravel, the drainage is as a rule good, although not excessive.

The Aroostook silt loam is of alluvial origin and represents the most recent flood plains of the streams along which it occurs. The type is subject to overflow, but this seldom happens except during the spring freshets, and by the time it is desirable to cultivate the land, the waters have drained away sufficiently and do not retard planting to any great extent, though farm work may be delayed a few days.

That phase which occurs along the Presque Isle Stream is, however, very poorly drained and, unlike the rest of the type, owes its occurrence to artificial rather than natural means. Across the Presque Isle Stream at Presque Isle there is a dam which has been in existence many years. This dam backs up water for 4 miles and it is along the pond thus formed that this phase occurs. During high water the streams, bearing loads of fine soil in suspension, enter this pond and encountering the quiet waters are compelled to dispose of this material. The deposits thus formed gradually increase in thickness until they reach a point just above the normal level of the water. In times of high water, however, the soil is overflowed.

The characteristic vegetation of this phase is a coarse swamp grass. It is very doubtful if a successful system of artificial drainage could be installed under present conditions. If, however, the dam should be removed, it is very likely that these areas would become naturally well drained. On all other parts of this type the original forest growth was ash and elm, but at present nearly every acre is under cultivation.

Because of the annual addition of fresh soil and decayed humus brought down by the spring floods, this is one of the most fertile types of soil in the area. Large crops of potatoes of excellent quality are secured, the yield not infrequently running more than 100 barrels per acre, although the average is considerably less than this, and the yield and quality are, as a rule, somewhat lower than on the Caribou loam. It is especially well suited to grain or grass and any other farm crop that will grow in this section. Oats yield from 40 to 60 bushels per acre, while 1 to 2 tons of hay is not an unusual crop. The fertilizer application is about the same as for the other types, being from 1,200 to 1,500 pounds, although larger increases in yield result from the same application than on the other soils.

At present none of the type is on the market. It is doubtful if any of this land with the improvements could be purchased for less than $100 an acre, while the price for the greater part of it would run somewhat higher. As is the case with several other soils of limited extent, no farms are made up entirely of this one type, so it is a difficult matter to get at the actual value.

Average results of mechanical analyses of fine-earth samples of the soil and subsoil are given in the following table:

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Mechanical analyses of Aroostook silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19603, 19607.....	Soil.....	0.1	0.7	0.4	6.1	15.7	62.7	14.6
19604, 19608.....	Subsoil.....	.0	.7	.8	6.7	13.8	63.7	14.4

AROOSTOOK LOAM.

The soil of the Aroostook loam consists of a dark-brown or sometimes yellowish-brown heavy loam 8 to 10 inches deep, containing perceptible amounts of medium to fine sand with a percentage of clay high enough to give the soil a sticky texture in wet weather. For the first 10 inches the subsoil is a mottled gray and brown silty loam to silt loam. At about 20 inches it changes to a mottled gray and brown very compact silt loam in which the gray color predominates. Owing to the fact that the type contains more clay than the other soils in the area it has received the name "clayey land" from many of the farmers. Very few stones occur and these are small. The type as a whole is easily handled, although it is somewhat more sticky than most of the soils.

Only three bodies of the type were mapped and the combined area of these is not over one-fourth square mile. Many bodies, however, too small to map were encountered. All of the type is found along the Aroostook River, and those areas mapped occur about 3 miles northeast of Presque Isle. The type occupies terraces and indistinctly developed terraces at the foot of slopes bordering the Aroostook River and is usually well drained, although, owing to the compact nature of the underlying layer of silt, it is somewhat more retentive than the other river-bottom soils.

The Aroostook loam belongs to the group derived from modified glacial drift. The underlying silt was laid down in quiet waters, but the surface soil has been influenced to some extent by washings from the adjoining slopes of the Caribou loam. Though all the type is now cleared and under cultivation, it is very probable that at one time it was covered with a thick forest of spruce, fir, poplar, and white birch, mixed with a few other hardwoods. Grain, grass, and potatoes are the crops grown, and while all do well it is generally acknowledged that this soil is not quite as well suited to potatoes as the more loamy and gravelly soils. Grass yields from 1 to 1½ tons of hay and oats from 40 to 50 bushels per acre. The fertilizer practice is about the same as for the other river soils.

On account of the small extent and the variability of the type no samples were taken for mechanical analyses.

AROOSTOOK SANDY LOAM.

The soil of the Aroostook sandy loam to a depth of 6 to 12 inches consists of a brown or yellowish-brown medium to fine sandy loam

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containing a perceptible amount of silt. The subsoil to a depth of 36 inches is a grayish-black or greenish-gray medium sand, containing small particles of quartz, calcite, and mica, but consisting principally of dark-colored shale, slate, and sandstone fragments. Pockets of a light-colored silty sand are of frequent occurrence in the subsoil. At about 36 inches the soil as a rule is underlain by a more or less impervious stratum which in the low-lying areas is a compact yellowish-brown clay or sometimes a bluish-gray silty clay, while in the more elevated portions the compact silty lower till is often found at a depth of less than 36 inches. On the upland side the type may grade into the Caribou loam, the line of demarcation in some cases being very indistinct. On the other hand a steep bluff marks the boundary between the two types. Immediately after a rain the soil has a very dark brown appearance, but as it dries the surface becomes lighter in color and approaches more nearly a yellow. As is usually the case with sandy soils, the type is loose and friable and therefore easily cultivated.

The Aroostook sandy loam occurs only along the Aroostook River and almost invariably occupies the second terraces, although in one or two cases it is found on what is apparently a first, though really a second terrace. The largest bodies of this type are found a few miles northwest of Presque Isle and across the river from Fort Fairfield.

As a rule, the type occupies comparatively level areas. In a few of the smaller bodies, where the soil occurs as long narrow ridges, as is the case near Beans, the surface is slightly rolling.

Notwithstanding the structure is rather loose and incoherent and the soil is underlain by a stratum of sand, it retains water to a marked degree and cultivated crops seldom suffer from drought to any great extent. This can probably be accounted for, in a measure at least, by the presence within 3 feet of the surface of the compact stratum which retards the water in its downward course, while the surface mulch that results from thorough cultivation prevents rapid evaporation. Such crops as oats and grass, however, which can not be cultivated, are apt to suffer to some extent from drought during dry seasons.

The Aroostook sandy loam is derived from modified glacial drift. The terraces which this type forms were the old flood-plains of the Aroostook Valley, along which the reworked glacial material was deposited.

Elm and ash were the native tree growths. At present practically all of the type is under cultivation, and like all other soils of the area it is devoted to the production of potatoes, oats, and grass. The yield of potatoes is from 70 to 80 barrels. Oats and grass produce fair yields, but the soil is not so well adapted to these crops as the heavier soils. The drainage is thorough and the soil warm and early

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for this locality, and for this reason it would probably make a good trucking soil. At present nearly all the vegetables consumed in the area are shipped from Boston and other southern points. As most of the Aroostook sandy loam lies near the larger towns, it would seem to offer good opportunities for the production of market-garden crops to take the place of the imported products.

From 1,200 to 1,500 pounds of commercial fertilizer is the usual application on this type. There is a slight tendency toward leachiness in this soil, and the effects of this fertilizer are not as lasting as on other soils. The addition of organic matter in some form would doubtless prove very beneficial to the type.

Since the areas are small, it is difficult to estimate the individual value of the soil type. When included with other soils and with such improvements as fences and buildings the land sells for $100 an acre.

Average results of mechanical analyses of fine-earth samples of the soil and subsoil are given in the following table:

Mechanical analyses of Aroostook sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19599, 19601	Soil	0.6	6.1	11.6	35.8	13.1	11.4	12.0
19600, 19602	Subsoil	.6	10.8	20.7	48.0	9.8	6.1	3.7

WASHBURN LOAM.

The soil of the Washburn loam is a very dark brown or black silty loam 12 inches deep. The subsoil is a grayish-yellow silty loam, mottled with brown and yellow, becoming a yellowish sandy clay at or near 36 inches. In a wet condition the soil is much blacker than when dry. In general the dark color is due to a high content of organic matter. The surface is strewn with granite, gneiss, and sandstone rocks, varying in size from 6 to 18 inches, and a few larger glacial bowlders. In fact, this one characteristic distinguishes it from the other soils of the area.

Like all other glaciated soils in the area, the type contains many small shale and slate fragments, thus giving a gravelly effect to the soil, the gravel as a rule being more abundant in the subsoil than in the soil. The covering of soil over the underlying calcareous shale is deeper than in the case of the Caribou loam. After the larger bowlders have been removed the type is not a difficult one to cultivate, although the poorly drained areas are not so easily managed.

The Washburn loam, which is found in every township, is of more common occurrence in the southern part of the area in the towns of Easton, Presque Isle, Mars Hill, Blaine, and Bridgewater, where it is closely associated with large swamp or muck areas. There are no

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large, continuous bodies, but it is found as narrow strips along some of the smaller streams and branches and in the hollows through which the drainage waters flow as small, isolated depressions and as narrow areas bordering bodies of Muck. In the last case the areas mark what was at one time Muck, but after the removal of the forest growth the soil dried out sufficiently to make cultivation possible. As cultivation continued the amount of organic matter gradually decreased, while there was a proportionate increase in the amount of earthy material, resulting in a gradual change from Muck to Washburn loam. In every case the type is found in those places where the conditions were favorable to heavy accumulations of humus, which gives the type its chief characteristic. In position and origin, as well as in texture, the type is intermediate between the Caribou loam and Muck, and to a certain extent has the characteristics of each.

As a rule, the type is fairly well drained, although the drainage is not as thorough as in the case of the Caribou loam, and in a few places artificial drainage would undoubtedly prove very beneficial.

The Washburn loam is of glacial origin, but the true characteristics of the glacial material have been marked to a large extent by the accumulation of organic matter and by the washing in of the soils from the surrounding areas.

The native vegetation of the type is what is locally known as "black growth" and consists of a dense forest of spruce, fir, cedar, and tamarack, with a few beech, birch, poplar, and white birch.

The Washburn loam is especially adapted to the production of grass, of which large yields are obtained. Oats and buckwheat also do well. Large yields of potatoes are secured, but in quality they are inferior and usually scabby, so it is not advisable to grow them on this soil. Hay yields from 1½ to 2 tons, oats 40 to 50 bushels, and potatoes 70 to 90 barrels per acre.

The fertilizer application is about the same as for other types of the area. At present there is no need for the addition of organic matter.

The type as a rule is not much in demand for general farm purposes, and where $10 to $12 an acre is paid for uncleared hardwood soils this type brings only $2 to $5, the value depending largely on the timber growth.

The results of mechanical analyses of fine-earth samples of soil and subsoil are given in the following table:

Mechanical analyses of Washburn loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19627	Soil	1.4	5.5	3.4	11.7	10.4	50.3	16.8
19628	Subsoil	3.2	7.2	4.4	21.1	19.7	40.1	12.9

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MUCK.

The Muck consists of black, thoroughly decomposed vegetable matter, mixed with soil that has washed in from adjacent uplands and ranging in depth from 8 inches to 3 feet or more. The subsoil is quite variable, depending somewhat on the position in which the type occurs. Along some of the smaller streams, and where the covering of muck is shallow, it consists of a grayish silty material resembling the lower till, while in other cases the top soil may be underlain by a very stony loam, so stony in fact that it is seldom possible to bore into it with the soil auger. The larger flat areas may have either one of these subsoils, or, as is more often the case, they may be underlain by a bluish clay. When properly drained the type is easily cultivated.

The Muck is found in bodies ranging in size from a few acres to 1 square mile or more. It occurs as strips of varying width along nearly all the streams, except the Aroostook River, and from all of the larger bodies narrow projections extend into the adjacent upland, indicating the source of a small branch which may be dry the greater portion of the year. In addition to this there are many large flat areas in which several streams have their sources and others where several small streams unite.

The type is of very common occurrence throughout all of the townships in the area, but the largest and most numerous bodies are found in Easton, Mars Hill, Blaine, Bridgewater, and the southern part of Presque Isle, while Caribou, Limestone, Fort Fairfield, and the northern half of Presque Isle have the least. The type as a whole is low and level, and during a part of the year, at least, is covered with water. Streams flowing through it have no well-defined channels, and during high water spread out over the adjoining Muck areas.

The subsoil of the Muck is of glacial origin and consists of both modified and unmodified drift. The soil, however, is of more recent formation, and where it occurs along streams and in the smaller depressions is the result of decaying vegetable matter which has become mixed to a greater or less extent with soils washed in from adjacent uplands. Many of the large, flat areas probably represent old lake basins, filled with organic remains and soil wash. This same process is gradually extinguishing many of the existing lakes, and, as the water is usually very shallow, the encroachment is relatively rapid. The vegetation on these newly formed muck areas along the lakes consists of a coarse swamp grass, pitcher plants, and a few tamarack trees. All other areas are covered with an almost impenetrable growth of cedar, spruce, tamarack, and fir.

On account of its poorly drained condition and the difficulty encountered in clearing the type comparatively little of it is under

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cultivation, although the farmers are making clearings of narrow strips on the outer edges from time to time. In addition to the thick growth of evergreen the ground is usually covered to a depth of 2 or 3 feet with old cedar bogs buried under decaying organic matter and overgrown with moss. When the trees are cut, the rubbish removed, and the muck exposed to the sun many of the areas dry sufficiently to permit cultivation without drainage and produce excellent hay. Many areas, however, lie so low that the land can never be used for agricultural purposes until artificial drainage has been established. Most of these areas are so situated as to make the drainage problem a rather simple one, as there would be little difficulty in finding an outlet for the water.

The yield of grass, to which crop the soil is especially adapted, is from 1 to 2 tons of hay per acre, and the quality excellent. It is very probable that celery would do well, and it is advised that experiments be made along this line, as excellent results have been obtained from growing celery on similar soils in other parts of the United States. The type is not suited to potatoes, as they are almost certain to be scabby and of inferior quality.

None of these lands are sold for agricultural purposes. The price they bring depends entirely on the timber growth and ranges from $2 to as high as $25 an acre, the latter price applying where there is a good stand of pulp woods near the market.

SUMMARY.

The Caribou area is situated in the eastern part of Aroostook County and extends north and south along the New Brunswick line for a distance of 40 miles. Its greatest width east and west is 15 miles. The total area is 530 square miles, or 339,200 acres.

The three largest towns in the county are Caribou, Presque Isle, and Fort Fairfield. Other important and growing towns are Mars Hill, Blaine, Robinson, Bridgewater Center, and Westfield.

The surface of the area is neither level nor hilly, though there are some high hills. There are many ridges and swells, and along the Aroostook River there are two distinct terraces. With the exception of the southeastern corner, all of the area is drained by the Aroostook River and its branches. The small streams furnish fine water power, which in many cases has been developed.

The transportation facilities are very good. Besides the main line of the Bangor and Aroostook, there are branch railroads extending to Limestone and Fort Fairfield and a line of the Canadian Pacific following the river to Presque Isle. No point in the area is more than 10 miles distant from the railroad.

The winters are long and cold, while the summers are comparatively short and hot. Frosts have occurred every month in the year, but

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are rare in July. Light frosts frequently occur in June and August. The rainfall is distributed throughout the year. Snow falls before the ground freezes and remains throughout the winter. As there is no frost in the ground and as the waters drain off rapidly, the land can be worked almost as soon as the snow melts.

The first settlement was made at Fort Fairfield in 1816 by pioneers from New Brunswick. Later on Dutch, English, Irish, Swedish, and French immigrants came into the county through the Provinces and settled at Caribou, Presque Isle, and New Sweden. After the construction of the "military road" in 1830, settlers began coming in from the southern part of the State. The first settlers grew some hay, oats, wheat, buckwheat, and a few potatoes for home consumption, but depended principally on forest products.

Introduction of starch manufacture in 1874 resulted in increased attention being given to the potato crop, and some potatoes were shipped over the Canadian Pacific. Not until the opening of the Bangor and Aroostook road in 1894 did potato growing begin in earnest. From that time grain and beef production and dairying declined and potato production became the leading industry. In 1908 the estimated crop of Aroostook County was 16,000,000 bushels. The greater proportion of this immense output is used for the table and for seed. The inferior tubers are sold to starch factories. The leading varieties grown are Irish Cobbler, Green Mountain, and Bliss Red. Large quantities of hay are shipped to Boston. These are the only money crops. Not enough grain is produced in the area to supply the home demand.

Potatoes, grass, and grain are grown on all the soil types. No single system of rotation is adhered to closely, but the general plan is a three-course rotation embracing four to six years, made up as follows: Potatoes one or two years, grain one year, grass one, two, or three years.

The price of ridge land with improvements and cleared of hardwood is about $100 an acre. Land is rented to share tenants for one-half the crop and to cash tenants for $10 to $25 an acre. About 91 per cent of the farms are operated by owners. The rented lands are about evenly divided between share and cash tenants.

Exclusive of Muck, eleven soil types have been mapped in the area. These vary in texture from sand to heavy silt loams, but the greater proportion of the area is made up of a friable silty loam. The absence of large glacial bowlders makes the use of farm machinery practicable.

The topography of the Caribou loam is rolling and the type is well drained. It withstands long dry periods to a remarkable degree. It is suited to all farm crops, especially to potatoes.

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The Caribou silt loam is similar in many respects to the Caribou loam and is adapted to the same crops. It contains a somewhat higher percentage of silt.

The Caribou gravelly loam occurs as piles of morainal material in strips along streams and in one case as a large and comparatively level area. The type is well drained and produces excellent potatoes, but is not quite so well suited to grass and grain.

The Caribou stony loam contains many large bowlders and is marked by small areas of rock outcrop. None of the type is cultivated. It is better that it remain in forest, although some areas would probably afford good pasturage.

The Chapman loam, as a rule, occupies low, plain country and is inclined to be cold and poorly drained. This type is poorly adapted to the production of potatoes, but on the better-drained areas grass and grain do well.

The Easton loam occurs in depressions and as narrow strips along swamp areas. It is not, as a rule, well drained, and while grass and grain do well the type is not suited to potatoes.

The Washburn loam is found in depressions and along stream slopes. This type produces large crops of grass and oats, but the potatoes are inclined to be scabby.

The Mapleton gravelly loam is of very limited extent. It is well drained, and where the rock is not too near the surface fair crops of grass, grain, and potatoes are produced. The type is well suited to apples.

The Aroostook silt loam is the most extensive of the river soils, and though of level topography and subject to overflow during the spring freshets is well drained. This is an excellent grass and grain soil, and potatoes do fairly well.

The Aroostook sandy loam is found on the second terraces and is well drained. Potatoes do well, but the yields of grass and grain are not quite equal to those of the heavier soils. Vegetables should do well on this type.

The Aroostook loam is of very limited extent. It is well drained and suited to general farm purposes.

Muck represents large accumulations of vegetable matter mixed with soil. Where drained, good crops of grass are secured. Celery should do well on this type.

The farmers are in general very prosperous. They have substantial dwellings, warm barns, and good horses. As a rule they practice up-to-date methods of farming. They could, however, improve their land and decrease their fertilizer bills by keeping more live stock and by following a three-year rotation of potatoes, grain, and clover.

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SOIL SURVEY OF LIVINGSTON COUNTY, NEW YORK.

By M. EARL CARR[a] and GEORGE A. CRABB, Assisted by P. O. WOOD and H. O. TIFFANY, of the New York State College of Agriculture, with a chapter on Orchard Soils by HENRY J. WILDER, and one on Drainage by E. O. FIPPIN.

DESCRIPTION OF THE AREA.

Livingston County lies in the west-central part of the State, midway between the Pennsylvania border and Lake Ontario. The total

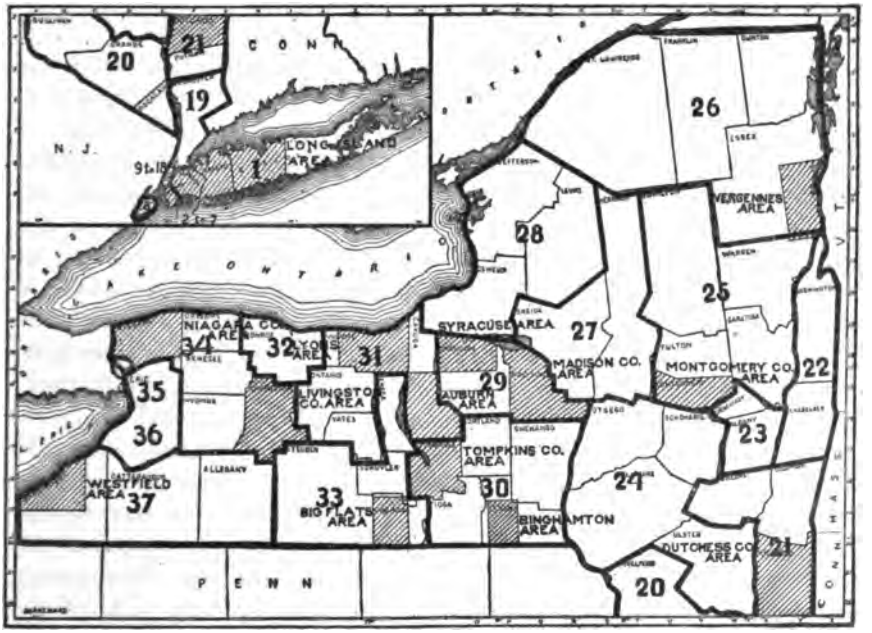

FIG. 2.—Sketch map showing location of the Livingston County area, New York.

area of its land surface is 402,560 acres, or 629 square miles. It has a water surface of some 8.5 square miles.

The county is bounded on the north by Monroe County, on the east by Ontario County, on the south by Steuben and Allegany coun-

[a] The author wishes to acknowledge his indebtedness to Prof. H. L. Fairchild, University of Rochester, for information in regard to Pleistocene geology and the origin of soil-forming material, and to Prof. Samuel Fraser, Geneseo, N. Y., for other valuable information furnished. Historical facts are from various histories of Livingston County.

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ties, and on the west by Wyoming and Genesee counties. The county is in general a rectangle, though none of the four sides have right lines.

The range in elevation in the county is considerable, amounting to 1,740 feet, the highest point (2,260 feet above sea level) being located in the northeastern corner of Springwater Township. The lowest point (520 feet above mean sea level) is along the Genesee River, between Caledonia Township of Livingston County and Rush Township of Monroe County. The whole southern portion of the county consists of high rounded hills separated by narrow valleys. It is in this section that the highest points are found. From this high hill country there is a gradual slope to the north to a comparatively low country characterized by rounded hills of the drumlin type, whose mean elevation above sea level is from 600 to 1,000 feet. There is no level land, except the floor of the Great Valley of the lower Canaseraga Creek and Genesee River.

The whole of the county except the extreme northern portion was greatly carved by preglacial stream erosion, and there has been considerable erosion subsequent to glacial times, particularly along the Genesee River between Portage and Mount Morris. At Mount Morris the river emerges from the hills and flows northward in an old preglacial valley. Along this upper portion or canyon section of the course of the river there are steep and vertical cliffs, varying in height to a maximum of about 600 feet. Waterfalls and rapids are conspicuous along this portion of the river in contrast to the low gradient and slack waters farther down its course. In the three falls at Portage the level of the river changes something like 250 feet, nearly half of which is in one fall.

Two of the narrow valleys in the high hill country are now in part occupied by "finger" lakes—Hemlock Lake, on the eastern edge of Conesus Township, and Conesus Lake, a few miles to the west on the western edge of Conesus and Livonia townships. The slope on the Livingston County side of Hemlock Lake is especially steep, rising from 896 feet, the level of the lake, to 1,900 feet at the edge of the flat top of Marrowback Hill, or 1,004 feet in less than three-fourths of a mile horizontal distance. Conesus Lake occupies a slightly wider valley and is bordered by hills of considerably less slope and altitude. At the heads of these two lakes there are low, rather flat valleys or fillings, that of Hemlock Lake opening out to the south to the Cohocton Valley in Steuben County and furnishing an entrance for the Erie Railroad, which traverses that part of the county, and that at the head of Conesus Lake extending south and then southwest, opening into the Great Valley at Groveland Station.

Probably the most conspicuous and marked physiographic feature of the county, aside from the gorge of the Genesee River and the

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Portage Falls, is what is popularly known as the Genesee Valley. This is not the Genesee Valley proper, but a preglacial valley which has been appropriated by the Genesee River northward from where it breaks out from the upland through the "High Banks" near Mount Morris. The head of this valley is at Dansville, some 15 miles from where the Genesee River enters it, and is occupied by the Canaseraga Creek, a tributary of the Genesee. From its head this valley extends northwestward to Mount Morris, thence north and northeast, and leaves the county at a point almost due north of its head. Its general shape is that of an Indian bow or an arc of a circle of great radius. Its length in Livingston County is about 35 miles and it has an average width of about 2 miles. The floor of the valley is practically level, there being no changes of more than a few feet in any cross section, except for some second-bottom levels in western Avon Township. Though there is a difference in elevation of about 180 feet between the Monroe County line and Dansville, more than 100 feet of it is in the upper few miles. The general altitude is around 550 to 575 feet above mean tide level. This great valley was very likely at some former time occupied by a "finger" lake similar to those occurring to the eastward, in the central part of the State, and occupying a similar physiographic position.

The drainage of Livingston County is accomplished by three different systems, the Genesee-Ontario-St. Lawrence, the Finger Lake-Oswego-Ontario-St. Lawrence, and the Cohocton-Chemung-Susquehanna-Chesapeake. The first of these is by far the greatest; in fact it probably drains at least 97 per cent of the total area of the county, the remaining 3 per cent being divided between the two latter systems. The principal stream of the county is the Genesee River, which forms a portion of the boundary between Livingston and Wyoming counties. Along this part of its course it receives no streams of considerable size, except the Silver Lake Outlet. From Portage to Mount Morris the river flows in a meandering course, much of the way between rock-walled banks several hundred feet high, and has a fall of 515 feet, the most of which is within the few first miles, where there are a series of scenic waterfalls and rapids, the highest waterfall being 107 feet. From Mount Morris northeastward the river has captured and flows through an old river bottom or narrow drained lake bed. Along this part of its course it meanders back and forth across the valley in loops and ox-bow bends, traveling many miles to gain a few. The distance in a straight line between the Mount Morris bridge and the Monroe County line on the west side of the river is only about 21 miles, but the channel of the river is at least 45 miles in length, thus going more than 2 miles to get 1 mile. The banks along this part of the course of the river are not rock, but a silty alluvium which lends itself readily to the will of the river

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waters, which easily cut away the banks and often change its course. Abandoned channels and ox-bow bends are not infrequent.

The gradient of this part of the stream is very small, not being more than 60 feet in 45 miles, or 1½ feet per mile. Although the channel here is cut 10 to 20 feet deep in the soft alluvium and during ordinary water flow is sufficiently large to carry all the water received by it, the low gradient and long, winding course prevent the passage of flood waters quickly enough, and the whole bottom is then inundated. These high waters sometimes happen during the growing season and result in great damage to the growing crops in the valley fields. However, each overflow has in a measure a compensating beneficial effect. With the slackening of the velocity of the flood water after it leaves the main river channel comes its inability to carry farther all of its load of fine detritus, and a considerable portion is dropped, thus silting up the surface inundated to a greater or less extent. This not only makes new soil, but is slowly, though surely, building up the bottom and making it less liable to damage from the overflow waters.

The Genesee River has but one large tributary in Livingston County, the Canaseraga Creek. This creek has its source in the southeastern part of Nunda Township, and after flowing south and eastward, crossing the corners of both Allegany and Steuben counties, it swings northeastward and crosses the southeastern corner of Ossian Township and passes by Dansville and to the northwest, occupying the upper end of the Great Valley and joining the Genesee on the opposite side of the valley from Mount Morris and the High Banks. In all of its course, until it reaches the vicinity of Dansville, the Canaseraga has a high gradient and flows through the shale hill country, some of the way in a bed worn from the country rock. Where the small streams join to form this creek at Barkertown the altitude is about 1,500 feet, but opposite Dansville it is only 620 feet. Like the Genesee, however, the lower course of the Canaseraga is through the silty floor of the Great Valley, and its gradient is very small. From Dansville to its junction with the Genesee it has a fall of only 50 feet, and more than half of this is in the first few miles below Dansville.

All along this part of its course the Canaseraga has an even more winding, tortuous channel than the Genesee. In time of high water the channel of the Genesee, not being able to carry its own waters, can much less carry those delivered to it by this tributary. Consequently the Canaseraga, not being able to discharge its waters into the Genesee, is more liable to overflow than the river itself, causing considerable damage; besides, much of the section adjacent to the lower course of the Canaseraga is slightly lower than the section adjacent to the river.

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These conditions are also augmented by the waters of the Canaseraga's main tributary, the Keshequa Creek, which rises in the northeastern corner of Allegany County, flows northwest, then northeast by Nunda, Tuscarora, and Sonyea, and empties into the Canaseraga a few miles above its junction with the Genesee. It has, throughout its whole length, except from Sonyea to its mouth, a swift course, the gradient being high. Some of its course is in a rock bed and between high rock-walled banks. The waters of this creek fall something like 875 feet in 18 miles, or nearly 50 feet to the mile. It is said that in time of flood the water actually piles up where this creek joins the Canaseraga, it not being able to spread out as rapidly as it comes down from the uplands.

Sugar Creek, having Ossian Township for its watershed, is the second largest tributary of the Canaseraga. There are also several other small streams which flow into the Canaseraga. The run-off of this creek is so slow and the bottom along a part of its course in the Great Valley is so low and level that over a considerable area the lands are swampy and difficult to drain and reclaim. It is believed that if the course of the Canaseraga Creek were straightened it would be able to deliver its flood water to the Genesee more quickly, which could then carry them on downward before the upper part of the river sends its surplus waters thus far downstream and thus prevent at least some of the flooding.

The Genesee River receives a number of small streams from the west below where the Canaseraga joins it, the largest being Beards Creek, which is made up of several small brooks, having their sources in the northeastern corner of Wyoming County. From the east the river receives only one stream of any size, Conesus Creek, the outlet of Conesus Lake.

Portions of Sparta, Groveland, Geneseo, Conesus, and Livonia townships lie in the basin of Conesus Lake, a small lake, having about 5.5 square miles of surface. The outlet of this lake, Conesus Creek, flows north, then west and north again through Ashantee and into the Genesee River at a point about 300 feet below the lake level, which is 818 feet.

Hemlock Lake lies on the eastern boundary of the county and Conesus Township, receiving the largest share of the drainage of Springwater Township and some from Conesus Township. Hemlock Outlet flows to the northeast into Ontario County, where it empties into Honeoye Creek, which is a tributary of the Genesee River. Honeoye Creek forms the eastern boundary of Lima Township and receives a considerable portion of its drainage.

A few square miles of the eastern part of Springwater Township are drained by small brooks, whose waters eventually reach Lake Ontario at Oswego. The waters of the northeastern corner of the township

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flow into Honeoye Lake, and the Cohocton River, a tributary of the Chemung, has its source within the township and shares in its drainage.

The first white people living in Livingston County were 24 white prisoners of the Indians. A missionary to the Senecas visited the "Genesee country" in 1765 and found these prisoners and Mary Jemison, the "White woman," who had come there in 1759. No settlements were attempted prior to the Revolutionary war, but immediately thereafter many of the men who were with Sullivan in his expedition to the region in 1779 returned and secured land and began the pursuits of agriculture, which has always been the chief source of wealth of the county. The New England States and Pennsylvania did most toward peopling the Genesee country in the early days of its settlement. The land was first exploited and sold by capitalists from Connecticut and Massachusetts, but later Robert Morris, the great financier of Revolutionary times, became interested, a township and village taking his name.

In 1790 William and James Wadsworth came to Big Tree, now Geneseo, the county seat, from Connecticut, and bought 2,000 acres of Livingston County soil. Later the same season they added 4,000 acres more to their holdings. The population at this time (1790) consisted of 37 families, numbering in all 189 people.

April 9, 1791, a town meeting, the first, was held at Canawaugus for the district of Geneseo.

A few Scotch settled at Caledonia or "Big Spring" in 1799. The first post-office of the county was established at Geneseo in 1806. The settlement of the county continued rapidly, and February 23, 1821, Livingston County was organized from parts of Ontario and Genesee counties, with a population of 19,800. It was named for Robert R. Livingston, an American statesman and jurist and Member of the Continental Congress. For the next decade and a half the increase in population was approximately 1,000 per year; then there was a falling off of 2,000 in the following five years. During the next five years, from 1845 to 1850, there was a rapid growth, the county attaining its maximum population of 40,875 at the end of this five-year period. From that time to the present there has been as a whole a constant decline in population, though of course there have been periods of temporary increases. In 1905 the population of the county was only 36,450, or nearly 4,500 less than its maximum population fifty-five years before.

Upon comparing the census figures for 1895–1905 with the soil map and the description of the different soil types it will be observed that in the townships where the higher-priced soils occur the population has either held its own or gained, and that in the townships which are occupied by the lower-priced soils the decrease in population is most noticeable.

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The present population consists largely of the descendants of the original settlers, though in recent years there has been a large influx of Italians, particularly in the villages of Geneseo and Mount Morris.

Much of the land has been held from generation to generation by the same family, and is now owned and operated by the grandsons and great-grandsons of the first settlers and owners. Practically all of the people of the county are engaged or interested in agriculture, which is the chief industry and source of wealth. There is but little manufacturing in the county.

The largest villages are, in order of their size, Dansville, Mount Morris, Geneseo, and Avon, all located along the Great Valley. Other important villages are Nunda, Caledonia, Lima, Livonia, Springwater, and Conesus.

For the first half century of the history of Livingston County transportation of its products was accomplished only by team and wagon. In 1840 the Genesee Canal was completed from Rochester to Mount Morris and extended to Dansville the following year. This waterway was the first improved transportation facility offered to the farmers of the region and was hailed with much rejoicing. It was extended through the southwestern corner of the county and to Olean, on the Allegheny River, in 1856, but never proved a success and was abandoned in 1878.

The first railroad transportation afforded the county was in 1852, but this was of little importance, as it affected only a limited section of the southwestern part of the county. In 1854 a railroad was built between Avon and Rochester, which was extended to Geneseo and Mount Morris five years later, and still later to Dansville. This railroad furnished the first efficient transportation for the products of Livingston County soil. In the last few years this railroad has been electrified between Rochester and Mount Morris, giving frequent and fast passenger service in addition to freight service. The trunk line of the Delaware, Lackawanna and Western Railroad from Buffalo to New York was completed across the county in 1883, affording excellent freight and passenger service to and from these cities. The Pennsylvania Railroad now operates a branch between Rochester and Olean over the route of the old Genesee Canal, and the Erie a line in the eastern part of the county—a division of the Buffalo, Rochester and Pittsburg Railroad—cuts across the northwestern corner of Caledonia Township. A branch of the New York Central lines extends across Caledonia Township from east to west, and the main line of the Lehigh Valley Railroad traverses the same territory and has a branch extending across Lima and Livonia townships.

The present transportation facilities of the county are made up of roads of six different systems—the Erie, the Lackawanna, the Pennsylvania, the New York Central, the Buffalo, Rochester and Pittsburg,

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and the Lehigh Valley. There are several other local railroads, including the Dansville and Mount Morris and the Genesee and Wyoming. An electric road, the Rochester, Corning, Elmira Traction Company, is projected and construction under way to connect the Conesus Lake region and eastern part of the county with the main lines of transportation on both the north and south.

The county highways are fair, though not nearly as good as they should be. Some of the main roads have been macadamized and further work along that line is under way and other work contemplated.

Rochester is the nearest large market, being only about 20 miles north of the northern boundary of the county. This city is now receiving more than one-third of its supply of fresh milk from Livingston County farms and demanding more. The Buffalo market is not far away, measured by fast-train service, and there is direct communication with it. Much of the produce of the region, however, is sent to New York City and the mining towns of eastern Pennsylvania.

Altogether Livingston County is well supplied with markets, which are consuming enormous quantities of all the products suited to the soils and climate of the region. There is not only room to extend the production of all of the crops grown, especially those of a perishable character, such as milk and other dairy products, fresh vegetables and orchard fruits, but the markets supplied are constantly consuming and demanding more and more of these products.

CLIMATE.

The prevailing climatic conditions of Livingston County are typical of the section in which the county is located. There is a wide range in temperature between the winter and the summer months. The winter season is usually from four to five months in duration, and generally there are short periods of extreme cold, the absolute minimum being −25° F. Very often mild temperatures prevail for short periods in the winter. The absolute maximum for the winter season is 69° F., showing a range of 94° F. for the season. The mean temperature of the winter months is, however, about 25° F. Heavy snows sometimes occur, the snowfall being always somewhat greater for the higher lying southern portion of the county than for the low-lying northern portion. According to the record the average snowfall at Hunt is nearly 1 foot greater than at Avon and nearly 1½ feet greater than at Hemlock Lake. The heaviest snows usually occur during the month of January. The mean temperature for the summer months is a little less than 70° F., the high extreme sometimes being nearly 100°. The mean for the spring months is about 45°, and for the fall months about 50° F. The annual mean temperature is 46° at Hunt and 47° at both Avon and Hemlock Lake.

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The precipitation is fairly well distributed throughout the year, though periods of excess and drought often occur. The greater proportion of the rainfall occurs during the summer months—June, July, and August. The records show that during these months nearly 1 foot of rainfall can be expected. The least precipitation occurs during the winter months of December, January, and February, when, as a rule, the amount is about 6 inches. For the spring and fall months the precipitation is about the same, the amount being intermediate between the other two seasons. The precipitation varies considerably from year to year, the amount for the wettest year being about 5 inches above the annual mean and the amount for the driest year being for the different stations some 5½ inches to 8¾ inches below the annual mean. The annual mean precipitation for the lower northern part of the county is between 29 and 30 inches, while that of the southern and higher portion is above 33½ inches, about one-tenth of which falls as snow.

The following table gives a detailed statement compiled from Weather Bureau records.

Normal monthly, seasonal, and annual temperature and precipitation at Hemlock Lake.

Month.	Temperature.			Precipitation.			
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for driest year.	Total amount for wettest year.	Snow, average depth.
	°F.	°F.	°F.	Inches.	Inches.	Inches.	Inches.
December	28	60	− 6	1.94	3.77	0.78	5.8
January	24	62	−20	1.62	.79	1.92	12.8
February	20	60	−19	1.14	.73	2.43	5.0
Winter	24	.....	.....	4.70	5.29	5.13	23.6
March	32	76	−9	2.05	1.03	3.89	4.0
April	44	81	16	2.53	1.15	2.60	7.8
May	56	85	28	2.78	2.72	.53	1.0
Spring	44	.....	.....	7.36	4.90	7.02	12.8
June	66	93	38	3.53	1.34	6.32	.....
July	71	93	47	4.19	4.36	4.19	.....
August	69	92	42	2.92	.95	6.02	.....
Summer	68	.....	.....	10.64	6.65	16.53	.....
September	63	89	34	2.26	2.45	1.57	Trace.
October	51	82	21	2.56	1.96	2.89	.2
November	39	69	13	1.72	1.24	1.56	2.3
Fall	51	.....	.....	6.54	5.65	6.02	2.5
Year	47	93	−20	29.24	22.49	34.70	38.9

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Normal monthly, seasonal, and annual temperature and precipitation at Avon.

Month.	Temperature.			Precipitation.			
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for driest year.	Total amount for wettest year.	Snow, average depth.
	°F.	°F.	°F.	Inches.	Inches.	Inches.	Inches.
December	27	64	− 8	1.85	1.65	1.70	10.4
January	23	68	−25	1.79	1.97	.86	12.7
February	20	67	−18	1.51	.64	.43	8.5
Winter	23	.....	.....	5.15	4.26	2.99	31.6
March	34	81	− 3	1.91	1.87	1.26	4.2
April	45	87	13	2.09	1.21	1.79	5.0
May	57	89	21	2.52	1.75	3.03	.8
Spring	45	.....	.....	6.52	4.83	6.08	10.0
June	65	95	35	3.38	1.96	5.09	.....
July	72	96	37	3.77	4.08	4.80	.....
August	68	97	39	3.02	.90	4.24	.....
Summer	68	.....	.....	10.17	6.94	14.13	.....
September	62	95	28	2.66	1.42	4.34	Trace.
October	50	89	14	2.54	.72	5.72	1.0
November	38	73	0	2.05	2.19	2.21	2.1
Fall	47	.....	.....	7.25	4.33	12.27	3.1
Year	47	97	−25	29.09	20.36	35.47	44.7

Normal monthly, seasonal, and annual temperature and precipitation at Hunt.

Month.	Temperature.			Precipitation.			
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for driest year.	Total amount for wettest year.	Snow, average depth.
	°F.	°F.	°F.	Inches.	Inches.	Inches.	Inches.
December	28	55	− 9	2.74	3.10	2.88	10.8
January	23	69	−15	2.72	2.70	3.78	15.6
February	22	75	−20	.99	.95	.40	5.5
Winter	24	.....	.....	4.45	6.75	7.06	31.5
March	34	84	− 9	2.60	1.89	3.05	9.5
April	44	80	17	2.10	2.00	2.66	4.0
May	55	90	22	3.68	2.51	2.37	4.1
Spring	44	.....	.....	8.38	6.40	8.08	17.6
June	66	92	34	4.11	3.20	5.23	.....
July	69	92	41	5.24	1.97	8.35	.....
August	66	92	35	2.34	.70	2.13	.....
Summer	67	.....	.....	11.09	5.87	15.71	.....

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Normal monthly, seasonal, and annual temperature and precipitation at Hunt—Cont'd.

Month.	Temperature.			Precipitation.			
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for driest year.	Total amount for wettest year.	Snow, average depth.
	°F.	°F.	°F.	Inches.	Inches.	Inches.	Inches.
September	61	92	28	2.54	4.52	2.22	.....
October	50	89	16	2.65	2.95	1.95	1.8
November	38	70	1	1.59	1.15	2.12	4.2
Fall	50	.....	.....	6.78	8.72	6.29	6.0
Year	46	92	−20	33.30	27.64	37.14	55.5

Of the three stations furnishing records two are located in the lower northern end of the county and one in the higher southern end of the county. The Avon station has an elevation of 585 feet above sea level and has a record for fourteen years. The Hemlock Lake station is 900 feet above sea level and has a record going back eleven years. The Hunt station is located 1,321 feet above sea level and has a record covering ten years. These tables were prepared by the Weather Bureau and include the record to January 1, 1909.

The average length of the period in which immunity from killing frost can be expected is 155 days for the Avon section. The earliest frost in the fall of which there is record occurred September 15 and the latest in spring May 31. The average length of the growing season for the Hemlock Lake section is 169 days, and the earliest fall frost recorded occurred October 2 and the latest in spring May 30. At Hunt the season is much shorter, being only 133 days. Here the earliest frost in the fall was on September 26 and the latest in spring May 31. From the following table, which gives the recorded dates of killing frosts, it can be seen that one can not reasonably expect immunity from frost before about the last of May in the spring, or after the latter part of September or first of October in the fall.

Dates of killing frosts.

Year.	Avon.		Hemlock Lake.		Hunt.	
	Last in spring.	First in fall.	Last in spring.	First in fall.	Last in spring.	First in fall.
1898	May 6	Oct. 29	May 8	Oct. 13	.....	.....
1899	May 15	Oct. 2	Apr. 17	Oct. 2	.....	.....
1900	.....	Oct. 20	May 10	Oct. 20	.....	.....
1901	Apr. 20	Oct. 5	Apr. 13	...do.....	.....	.....
1902	May 29	Sept. 15	May 10	Oct. 10	.....	.....
1903	May 31	Oct. 22	May 2	Oct. 24	.....	.....
1904	May 12	Sept. 23	Apr. 22	Oct. 7	.....	.....
1905	May 21	Sept. 26	May 2	Oct. 26	May 24	Sept. 26
1906	...do.....	Oct. 8	Apr. 28	Oct. 31	May 30	Oct. 1
1907	May 25	Oct. 2	May 30	Oct. 21	May 31	Oct. 9
1908	May 5	Oct. 3	May 5	Oct. 3	May 5	Oct. 3
Average	May 14	Oct. 16	May 2	Oct. 18	May 22	Oct. 2

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AGRICULTURE.

Agriculture is and always has been the backbone of the wealth of Livingston County. The soil is its greatest asset and the creation of new wealth from it annually has always been the chief aim of the people. Before the advent of the white settlers in the region the Indians grew corn, vegetables, and fruits, probably to a much greater extent than they did in any other section of the State. Sullivan's expedition during the Revolutionary war was planned to destroy the growing crops and stores of products of the soil of the region.

Some idea of the Indian agriculture of the "Genesee country" can be obtained by the following quotation from the report of that expedition:

> Throughout the region * * * especially in the valley of the Genesee, he found corn fields producing crops exceeding in quality and quantity anything to which the soldiers had been accustomed in their eastern homes.

They found ears of corn measuring 22 inches in length. They found extensive fields of corn and vegetables growing on the river flats east of the Indian village, Little Beardstown, now Cuylerville, and an orchard near that town. It is said that at this place 200 acres of corn and 1,600 fruit trees were destroyed, besides a store of 20,000 bushels of corn.

All of the early settlers were tillers of the soil and at once cleared fields and began the production of farm crops. Wheat was one of the first crops to be grown, but for a long time it was marketed with difficulty. The first crop of this cereal to be harvested in the region of the Genesee country was grown in 1789 near Dresden, Yates County. In 1804 a load of 100 bushels of wheat was sold for 5 shillings per bushel and transported to Albany, about 225 miles away, by wagon with a four-ox team, where it sold for 7 shillings per bushel. By 1850 Livingston County had become a great wheat-producing county, and Geneseo, the county seat, the greatest inland wheat market of the State. The production then amounted to 1,111,986 bushels. Five years later the yield was practically the same, but during that year (1855) the weevil appeared in the wheat and for several seasons the crop was almost a total failure. This caused the yield to fall off greatly, so that the production reported in 1860 and 1865 amounted to only about 25 per cent of that reported for the years 1850 and 1855. Since that time "Genesee wheat" has never regained its place in the market, though the annual production has been about three-quarters of a million bushels, according to the reports of the census. The production for the last census year (1899) was 729,590 bushels, a yield of about 16 bushels per acre. For this county, at least, the wheat weevil hurt wheat farming more than the development of wheat production on the cheap lands

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of the Middle West, for the production of wheat in Livingston County shows no change due to this competition.

In the early days of the settlement of the county access to outside markets was difficult, transportation facilities slow and inefficient, and the cropping systems had to be planned accordingly. There were many distilleries using the grain crops, asheries, and much charcoal burning, the two latter industries accompanying the clearing of the land of the timber, there being no market for lumber. About 1800 and later considerable hemp, flax, and tobacco were grown, but these crops are not now produced.

At the time of Sullivan's expedition in 1779 it was said that on the river flats east of Mount Morris there were "not less than 6,000 acres of the richest soil that can be conceived, not having a brush standing, but filled with grass considerably higher than a man's head." In 1793 Thomas Morris wrote of "the famous Genesee flats. * * * The soil is remarkably rich, quite clear of trees, and produces grass near 10 feet high, * * * cultivation is easy and the ground is grateful."

In March, 1809, 60,000 acres of land were offered for sale on the west side of the river. The following is quoted from the advertisement:

> The intervales and swales * * * are timbered with elm, butternut, white and black oak, walnut, etc. The uplands with sugar maple, beech, basswood, wild cherry, white and black oak, chestnut, etc. Some of the intervales or flats will produce, if well cultivated, 80 bushels of corn, 800 pounds of hemp, or 2,000 pounds of tobacco on an acre, and other crops in proportion. Some of these lands are said to have produced 1,000 pounds of hemp and 100 bushels of corn per acre.

A practical dairyman was brought to Livingston County in 1810, and the same year fruit trees were ordered from Long Island, thus laying an early foundation for both the dairy industry and fruit growing. County agricultural fairs were begun regularly in 1841, and were held annually until 1896.

The dairy industry was stimulated greatly by an importation of pure-bred Shorthorns in 1836. Numerous other importations of blooded stock were afterwards made from time to time. In 1853 the "Livingston County Association for the Improvement of Stock" was formed and the following year agents were sent abroad to select stock. These agents purchased and imported 24 head of choice pure-bred cattle. From these importations many of the fine herds of cattle now found in the county are descended. Thus Livingston County early acquired wide celebrity for choice herds of blooded cattle and other stock.

Hop growing was introduced in the southwestern corner of the county about 1850, the production for that year being 7,018 pounds.

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The height of the hop industry in the county was reached about 1880 when, according to the census, the production was 310,574 pounds. From that time the acreage and production gradually declined until 1908, when the last commercial crop was grown. The acreage yield of hops was never high, and on that account, coupled with the low and fluctuating prices and the development of other lines of farming, the industry became unprofitable and has been superseded by other forms of agriculture.

Barley was extensively grown from 1850 to 1880. The crop of 1869 amounted to almost a half million bushels, but the production had dwindled in 1899 to less than 50,000 bushels, or to 10 per cent of the maximum. There is at present, however, a tendency to a larger production of this cereal.

Oats, corn, and potatoes have long been staple products of Livingston County soils. Oat production increased until 1860 and has since been about stationary—approximately three-quarters of a million bushels annually. Potatoes have continually increased in favor, the production in 1899 being nearly 1,000,000 bushels. Corn production has always been conservative, with a fairly uniform output, approximating a half million bushels annually for the last fifty years. Beans during the last few decades have become one of the important crops of the county, with a production of about a quarter of a million bushels annually in recent years.

Dairying, stock raising and feeding, and the production of wool and mutton is and has been an important industry. Many steers are bought in the west and southwest and in stock yards and brought to the region, where they are grazed and fattened.

The sales of live stock within the county for the year 1899 amounted to $383,600, and of stock slain on the farms $124,814, or a total of $518,414. The value of the dairy products was $409,608, and there were 63,713 fleeces of wool shorn, aggregating 424,500 pounds. The total value of farm live stock as given in the Twelfth Census was $2,282,382.

In recent years the production of canning crops has been undertaken, especially in the vicinity of Mount Morris and Geneseo, there being two canning plants at the former place and one at the latter. The crops grown for this purpose are mainly sweet corn, peas, and string beans, though some tomatoes, spinach, asparagus, etc., are also grown. Some of these crops are sent to canning plants outside the county.

About sixty years ago a few farmers in the vicinity of Dansville began the growing of fruit trees from seed. From this small beginning one of the most important nursery sections in the country has resulted, controlling the trade in some kinds of nursery stock. The business has always gained ground, probably owing to a large

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extent to the freedom of the section from scale, insect pests, and fungous diseases. The Dansville nursery business is practically wholesale, most of the stock being grown by contract. Fruit is the specialty, but few ornamentals being grown.

Briefly stated, the soil conditions for the different varieties of nursery stock are, for apples, medium to light soils; for plums, medium to heavy soils; for cherries and peaches, the lighter soils; for pears, the heavier soils; and for ornamentals, the light to medium soils.

The nursery industry in Livingston County, which is confined to Dansville and vicinity, has grown to such an extent that the Twelfth Census (1900) reports 2,752 quarter acres, or 688 acres, devoted to it, with sales of $103,046 worth of stock for the year 1899. Since that time there has been a steady and healthy increase in the industry. Incomplete returns for 1908 from the New York State Department of Agriculture place the acreage at 758 acres, the number of growers at 109, and the total estimated number of trees at 20,595,000. Of this number 19,657,000 are given as fruit trees, 572,000 as ornamental trees, and 366,000 as bush and vine fruits. Of the fruit trees cherries are the most extensively grown, the number being 7,225,000. Plums are second, with 5,407,000 trees; pears are third, with 2,564,000 standards and 625,000 dwarfs, a total of 3,189,000 pear trees; and apples are fourth, with a total number of 2,715,000 trees. Peaches and quinces are about equal in importance, with between 500,000 and 600,000 trees each.

The production of grapes on the steep hillsides east of Dansville has for a number of years been of considerable importance. A large vineyard, some 200 acres, on the same soil type on the slope west of Hemlock Lake has also been a success. In more recent years grape growing in the vicinity of Geneseo has been successfully introduced by a colony of Italians. Practically the whole product of all of these vineyards is made into wine, though the grapes are of excellent quality for table use.

The total area of the county is 402,560 acres, of which 92 per cent, or 373,660 acres, was reported by the Twelfth Census (1900) as being farms. Of this farm acreage only 80 per cent, 74 per cent of the total, or 301,860 acres, is classed as improved.

The agriculture of the present can be summed up as grazing and stock feeding, dairy farming, wheat, bean, and potato farming, fruit and nursery stock production, and the growing of canning crops. About 175,000 acres, or nearly one-half of the county, is in sod, of which three-fifths is pasture land and two-fifths mowing land. Approximately 125,000 acres, or about one-third of the acreage of the county, is in cultivated fields. Next to the forage crops wheat has the largest acreage, nearly 50,000 acres being devoted to its production. Oats and beans are next, each with an acreage of nearly

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13,000 acres, and potatoes with nearly 10,000 acres. All other crops are comparatively insignificant in their acreage, varying from about 2,000 acres down to a few hundred acres.

The value of farm products not fed to live stock, grown during the season of 1899, was nearly $3,000,000, or approximately a gross income of 15 per cent on the valuation of farm land, buildings, improvements, machinery, etc. This income amounted to $878.56 for each farm and $7.68 for each acre included in the farms. That there has been a gratifying increase in this agricultural income since the census year is certain, though there are no official statistics available to show it.

The farmers of Livingston County have recognized the adaptation of soils to crops only in part. The Muck soils, where drained, cleared, and cultivated, are always utilized for the production of those crops to which they are best suited. The Volusia soils of the southern part of the county are devoted only in part to the crops best suited to them, many fields and farms being utilized in attempts to produce crops for which the soil is unsuited. Wheat, beans, and corn are as a rule grown on soils adapted to their production, though in a good many instances this is not the case. The average acreage yield of beans for the county—about 10 bushels—will not pay the cost of producing them. However, if they were planted only on soils and fields adapted to them, the average yield would without question be raised to a point high enough to give a reasonable profit. The same is true of wheat, corn, and other crops. Dairying and grazing are generally carried on on soils adapted to such forms of farm industry. Alfalfa is being introduced into the county to a considerable extent and almost always is planted on soils adapted to producing it, thus reducing to a minimum the chances for failure and discouragement in its production. Fruit-tree planting in the past has been done in a haphazard way, the orchards all being small and planted with scarcely any regard to differences in soil or soil conditions. Recent plantings, however, some of them on a commercial scale, have been located with particular reference to the differences of soils and of soil conditions, though in further extension of the orchards even more care must be used in order to insure the best success, and more care must be exercised to select not only the right kind of soil and to see that other conditions are favorable for orchards as a whole, but also to select the right kind of soil for each particular variety.

Systematic rotation of crops is not as generally followed in Livingston County as it should be. The general farm practice in vogue necessitates a long-course rotation. The difficulty in the utilization of some of the types of soil found in the county for intertilled crops and their poor reputation for some of these crops, and consequent

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use as permanent pastures and mowing lands, interferes with the establishment of any regular system of rotation upon them. On other soils which are easily tilled and extensively utilized in the production of a wide variety of crops, short-term rotations are successfully used. Permanent sod is rarely found on these soils.

The most general system of rotation in use is spring grain crops, beans, oats, etc., one year, wheat with grass seeding one year, sod for the production of hay two years, sod for pasturage two years or more. That this rotation—six years or more—is too long and that the provision in it for legumes is insufficient is clearly evident.

The following rotations are suggested for the various series of soils and systems of farming practiced in the county:

For the Volusia soils the main money crop should be late Irish potatoes, and they should be grown with some form of animal husbandry, possibly dairying, stock grazing and feeding, or sheep raising.

Of this soil series probably one-third of the land will be hillside forests or permanent pastures. These permanent pastures usually need to be and can be much improved by an occasional light top dressing of stable manure, possibly five or six loads per acre. The weeds on such lands should be mown in June and July before they are in full bloom, and every two years about 50 to 60 cents worth of grass seed should be sown per acre early in the spring. This seed might consist of a mixture of 2 pounds of red or alsike clover, 2 pounds of timothy, and 1 pound of Kentucky bluegrass.

The rest of the land might be divided into three or four fields and a three or four course rotation adopted, consisting of: For the three-course rotation, first year, potatoes for sale and a few acres of ruta-baga turnips and an acre or so of cabbage or rape for sheep feed, or part potatoes and part corn for ensilage on the dairy farm; second year, seeding to timothy and clover, alsike preferred, if difficulty is experienced in growing the red clover, with oats as a cover crop; third year, clover and timothy for hay. This may be made into a four-course rotation by leaving the sod for hay another year. The three-course rotation is an excellent one for a farm where the main money crop is potatoes.

Ruta-baga turnips and the long red mangel wurzel beets can be grown to advantage on the high hills occupied by these soils, where corn does not thrive, for sheep and cattle feeding. If run as a dairy farm, a few acres may be sown to peas and oats in the second year to provide green feed in the summer. Another might be, potatoes one year, buckwheat and seeding one year, hay one year. If any of these rotations are followed, together with judicious fertilization and management of the soils, the fields should be in successively better crop-producing condition at the end of each rotation. Provision could well be made in the management of these rotations for a season set

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apart for the growing of a crop to be turned under as green manure. The same suggestions will also apply to the most of the types of the Caneadea series of soils, though corn is much better suited to these soils than it is to the Volusia series.

A common system of rotation for the Dunkirk soils is: First year, beans; second year, wheat and seeding; third and fourth years, hay; fifth and sixth years, pasture. The beans are grown at little profit, except that the pods are valuable for sheep feed. If this be the main reason for growing them it would be much better to recast the rotation, and for a sheep or other live-stock farm on the loam or the lighter soils of the series it might be: Potatoes, one year, corn one year, oats or barley and seeding to alfalfa or timothy and clover one year, alfalfa several years, or the timothy and clover for hay two years. This would furnish the best kind of feed for sheep, since there would be home-grown roughage—alfalfa—which, with a little corn, oats, or barley, would carry the stock, and the potatoes would be a good money crop. According to the last census, Livingston County has more sheep than any other county in the State; therefore the question of feed for such stock is of prime importance.

A rotation for the heavier soils of the series on which potatoes do not thrive well could be: Corn for ensilage one year, oats one year, wheat with seeding to timothy and clover one year, hay one or two or three years. This is a good rotation for a dairy farm, but involves the purchase of more grain than would be necessary if alfalfa were grown. Wherever possible in connection with dairy farming some alfalfa should be grown, thus enriching the soil with nitrogen from the air and at the same time producing at least a portion of the concentrated feed necessary.

The overflow of the Genesee series interferes with the establishment of any regular system of rotation, but the following might be carried out in a general way: Some of the canning crops, such as string beans, peas, or sweet corn, or corn for ensilage, one year, followed by corn after the beans and peas, or directly by seeding, with oats as a cover crop, using a small quantity of oats for seed; meadow sod for several years, followed by grazing for a number of years.

These recommendations, it must be observed, are very general and would not be suitable for all soils and soil conditions prevailing within the different series. The individual farmer must work out on his own farm and adopt that rotation which fits his soil, his conditions, and his system of farming.

The money crop of each rotation, the fertilizer treatment of the soil, and the varieties of each crop and of clover and grasses used in seeding must all be made to fit the particular type of soil, holding in mind the class of farming to be followed, and, of course, will vary with each individual farmer, with each individual soil, with the drain-

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age conditions, with markets and marketing facilities, and with transportation facilities.

The agricultural methods and practices are fairly well suited to present conditions. That section of the county nearest the Rochester market is largely given to the production of supplies of the quickly perishable kind for that market. For instance, the township of Avon furnishes over one-third of the milk supply of the city of Rochester. The region around Mount Morris and Geneseo has a large acreage devoted to the production of canning crops and fruits, these being used by local canning establishments. The region around Dansville, farther from the markets, is extensively used in the production of nursery stock. On the high hills of the southern townships, where access to shipping points and markets is not so good, the production of potatoes is one of the chief industries.

Like practically all agricultural sections of the Northeastern States, the farmers of Livingston County are somewhat handicapped in securing labor, both as to quantity and efficiency. Near Mount Morris and Geneseo the labor conditions are considerably alleviated by the Italian population of these two villages.

At the time of the maximum population, in 1850, there were 2,503 individual farms, or one farm to every 16⅓ inhabitants. During the next twenty years the number of farms increased to 3,365, or 34 per cent, while the population decreased 2,566, or approximately 6 per cent. The census of 1900 gives the number of farms in the county as 3,267, a decrease in thirty years of 98, or one-third of 1 per cent, while during the same period the population decreased by 1,250, or 3 per cent. During this fifty-year period the number of farms had increased and the population had decreased so that the ratio of the number of farms to the population increased from 1 : 16⅓ to 1 : 11⅓. The average size of the farms was 114.4 acres. A number of holdings amounting to several thousand acres each makes it certain that a good many farms, probably much more than 50 per cent, are much smaller than the average size. Of the number of farms, 1,813 were operated by the owners, 329 by part owners, 292 by cash tenants, and 722 by share tenants. Thus a little more than one-half were operated by owners, 11 per cent by part owners, 9 per cent by cash tenants, and about 23 per cent by share tenants.

A study of land and farm values of Livingston County both in the past and present brings out strongly the continuous development of agriculture within the county and the different value always given to the different soils.

The earliest sales and lowest price of which any record can be found was in 1790. The Wadsworths bought in that year 2,000 acres for $160, or 8 cents an acre. Later during the same season they added 4,000 acres to their holdings, but for this purchase they

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had to pay 50 cents an acre, an advance of 525 per cent. Two years later the price had advanced another 100 per cent, $1 an acre being the price at which the "Genesee country" lands were advertised in the Eastern papers. In 1795 selling prices had advanced to $2 to $2.50 an acre.

The muck beds at South Lima were formerly considered worthless, and before drainage they would not be accepted at any price, even in payment of debt. However, since they have been drained they have become the highest priced land in the county, some fields selling for $350 an acre, with the present asking price $400 an acre.

The following table gives the valuation of the farm lands, with buildings and improvements, for the various census years, since 1850:

1850	$14,379,416	1865	$18,693,092	1880	$22,659,985
1855	22,406,233	1870	25,674,042	1890	23,115,850
1860	15,987,573	1875	24,061,314	1900	18,368,062

These figures show the maximum valuation of the farm lands of the county to have been during the period from 1870 to 1875.

The present valuation and selling price of the farm lands of Livingston County show more forcibly than ever before the difference in soils and soil conditions. In the equalization of the assessment rolls of the county, Ossian Township, 90 per cent of which consists of the high hill soils (Volusia), is always given the lowest acreage valuation, and Avon Township, which is occupied largely by one of the best of the Dunkirk soils, is always given the highest acreage valuation.

The range in prices of farms per acre in the different parts of the county bears a direct relation to the kind of soil. This range is extremely wide, the lower prices being from $8 to $10 per acre and the highest $400 per acre. These low-priced farms are invariably of one particular soil type and the high-priced ones are always of another particular soil type, no other soil even closely approaching it in price for agricultural purposes.

In the consideration of ways and means for the improvement of the agriculture of the county we must take into account many things. Thousands of dollars in the value of the crop production of the county are lost annually through poor and inefficient drainage of its soils. Therefore, the first essential in the improvement of Livingston County agriculture is the question of complete and thorough drainage, both surface and underground.

No stable and permanent improvement in agriculture can be made without working out and systematically following a comprehensive and rational adaptation of soils to crops. The best success in the growing of any crop is only possible when that crop is planted and grown on soils peculiarly adapted to its production. In this connection the rational extension of alfalfa on all soils of the county

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which are adapted to growing it is desirable and would eventually do much for the increase of the wealth and the improvement of agriculture. Likewise, the extension of fruit production on a commercial scale, planting varieties adapted to the different soils, is an essential to be considered. The limitation of wheat, corn, beans, and in fact all staple and special crops to the soils best suited for their production is also of extreme importance, and would do a great deal toward increasing the annual value of the farm crops produced from the soils of the county. The rotation of crops must also be more carefully planned and followed than ever before, a suitable rotation for each soil type being worked out, and here the fact must be considered that the adaptation of soils to crops limits the kinds of crops which can with the best success be introduced into the rotations.

A third step in the betterment of the agriculture of the county and region lies in the improving of methods of handling the various soils. A matter of prime importance in this connection is the plowing and the preparation of the seed bed. If these fundamental operations are poorly performed, as is too often the case, no amount of effort in the subsequent tillage can overcome the bad effects. Some of the soils of Livingston County should never be fall plowed, while others can be fall plowed without detriment. Some soils can be plowed and handled under an almost limitless range of moisture conditions, while others can be handled only under a very narrow range of moisture conditions. For the best success in crop production, plowing—the most important and too often the least properly performed operation of soil management and cultivation—should be regulated as to time, depth, and moisture conditions to suit each soil and each crop. After the proper preparation of the soil to receive the seed, it is essential in intertilled crops to follow with frequent and thorough surface cultivation in order to conserve moisture, to provide ample feeding surface for the plant roots so that their development may be easy, and to rid the soil of weeds. If these different operations were carefully performed by all tillers of the soil the results would be reflected in increased acreage yields and decreased unit cost of production, and consequently a greater net production of new wealth from the potential wealth of the soil.

Manurial and fertilizer practices are not to be lost sight of in any scheme or system for agricultural improvement. Many of the soils of Livingston County are deficient in organic matter, which next to drainage is probably of the greatest importance in the economy of crop production. The production of grain and hay crops for sale has to a large extent robbed the soils of their original humus content, until some of them can not longer produce remunerative yields of such crops. All forage crops grown should be fed on the farm, the stable

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manure being returned to the soil, thus making the process one of borrowing from the soil instead of robbing it. The selling of hay and other forage crops should never be practiced, except as the money received from such sales is used in purchasing for feeding upon the farm concentrated feeds with which to balance the feeding ration. The rational extension of alfalfa to all soils on which it will succeed without too great difficulty and the growing of more of the red clovers and other legumes will aid greatly in the restoration of the organic matter content of the soils. These practices will enrich the soil with nitrogen from the air at a cost simply of care and intelligence on the part of the husbandman instead of actual cash outlay often at high prices.

In order to insure success in the production of legumes in general, the liming of the soil is often desirable and sometimes absolutely necessary. Chemical examination of a number of samples of soil shows either a low or no percentage of carbonates, indicating the necessity for the use of lime. Next to the liberal use of stable manure and the growing of leguminous crops in the restoration of the organic content of the soils is the growing of green crops for soiling; that is, feeding green in connection with dairy farming, or for plowing under as green manures. If these crops are to be used for soiling purposes, oats and Canada field peas are suggested, as they usually grow well and can be sown early and furnish a heavy tonnage of valuable, succulent feed which can be used when pastures are short, and the peas being a legume help to improve the condition of the soil. However, if they are to be used simply as green manure, buckwheat, rye, etc., are desirable. These crops make a luxuriant growth and naturally leave the soil in better condition. Much has been accomplished in these matters by the prevalence of the "Wadsworth lease," or modifications of it, used in renting farm property. This form of lease prevents the sale of any hay or straw and requires that a certain acreage of clover must be put down each year with the wheat crop.

A considerable proportion of the agricultural lands of the county are in sod, much of which is permanent pasture and mowing, 70 per cent of the Wadsworth lands being in sod. Taking this fact into consideration, the question of the improvement of permanent sods is of great importance. But little work along this line has ever been attempted in America, though such work is common in English and continental European agriculture.

The reseeding of permanent sod land is profitable. This reseeding should be preceded by harrowing, and on mowing lands this operation should follow top dressing with stable manure. In pastures the harrowing distributes the droppings of the stock, disturbs the mosses, and prepares the land for seedage.

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Top dressing of mowing land should be done in the fall of the year, spreading from 8 to 10 loads of manure to the acre as evenly as possible. If commercial fertilizer is used, 100 pounds to the acre of about a $30 grade is suggested, the nitrogen as a nitrate, the phosphoric acid in the form of floats (ground, untreated phosphatic rock), and potash to be applied in the springtime.

The seed used should not exceed $1 an acre in cost, about 4 pounds each of red clover and timothy being used, the timothy being applied in the fall and the clover in the spring of the year. For pasture sods about 6 loads of stable manure an acre is the proper application, and the first year's seeding should be the same as for mowing sod land, followed the second season with some Kentucky bluegrass and meadow fescue. Practical and highly profitable results have already been obtained in Livingston County by the above treatment.

It is difficult to state which of these suggestions, and others which might be made, are of the greatest importance, as they are all intimately connected and the best results can not be attained by the accomplishment of any one alone to the exclusion of all or any one of the others. They are all of importance and their accomplishment would be an immense stride forward in the improvement of Livingston County and New York agriculture.

SOILS.

The diversity of the soils of Livingston County is greater than has ever before been encountered in any one county or area, thirty-five distinctly different soil types or soil conditions having been recognized and mapped during the progress of the survey, as shown by the map accompanying this report.

The origin of the materials from which the soils of Livingston County have been derived and the processes they have undergone in the formation of the soils are as greatly diversified as are the soil types themselves, with their textural and structural characteristics. Some of the soils are formed from local materials and some are formed from materials foreign to the immediate locality; some are the results of feeble glaciation, viz, the Volusia series of soils; some of heavy glaciation, viz, the Dunkirk series of soils; some are formed from glacial wash materials, some from more recent water action; some are formed from reworked and water-deposited materials, viz, the Genesee and Caneadea series and a number of the types of the Dunkirk series, as the clay, stony clay, silt loam, gravelly loam, gravelly sand, gravelly sandy loam, and fine sand; and some from reworked but not water-deposited material, as the Dunkirk loam and Dunkirk fine sandy loam. One type is the result of the accumulation of the organic remains of plant life (Muck) and another

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is the accumulation of inorganic material secreted by chara, an aquatic plant, and the shell remains of aquatic animal life (Warner's loam). And, finally, some are influenced largely by the residual weathering, breaking up, and disintegration in place of the underlying country rock, as Honeoye stony loam, Livingston loam, and Warren shale loam.

Considering the geological derivation and processes of formation of the principal soil areas, Livingston County can be divided into two parts, the first a region from which the soils are derived directly from the weathering and erosion of a thin mantle of glacial till, the second, a region from which the soils are derived from the weathering and erosion of a thick mantle of glacial débris, and from lacustrine deposits of glacial material. This latter part can be further divided into three sections, according to the character and coloration of the soil-forming materials and the geological time of their deposition.

The former part of the county consists of a high hill country carved into its present configuration by preglacial erosion and then thinly covered over with a mantle of glacial till, or, in other words, a region of feeble glaciation, the till deposit being for the most part derived from the ice grinding and moving of the underlying country rock formations of shale and sandstone. These rocks are all of Devonian age and belong to the Portage and Chemung groups. The weathering of these rocks and the shallow morainic till derived from them has formed a series of soils of light color, which has been designated the Volusia series.

This series of soils [a] is of wide extent, covering in all an area of about 15,000 square miles, or 9,800,000 acres, in northwestern Ohio, northwestern and northeastern Pennsylvania, and southern and south central New York. They range in color from pale yellows and browns to light and dark grays and in texture from a heavy silt loam to a comparatively light gravelly loam. They cover about one-fourth of the total area of the county, their extent being nearly 162 square miles, or 103,552 acres. Three types of the series occur and are shown on the accompanying soil map of the county. These types are the gravelly loam, the loam, and the silt loam, the last being the predominating type and the gravelly loam of the least importance in areal extent.

The remainder of the county, or second part, consists of low level, high level, and recent water-carried and deposited materials derived largely from heavier deposits of glacial débris.

In the low-level section of this part of the county there was much less action by preglacial erosive agencies. The underlying country rock, shale, sandstone, and limestone of Devonian age have con-

[a] See Bulletin 60, Bureau of Soils. A Preliminary Report on the Volusia Soils, their Problems and Management. By M. Earl Carr.

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tributed only a little to the soil-forming material, though in many places residual decay of the underlying shales contributes to the formation of the subsoil, and much of the stone content is from the Onondaga limestone. However, by far the major portion of the soil-forming material of the section is derived from the weathering of the material brought in from the north by the ice. Some of these soils, viz, the gravelly loam, gravelly sandy loam, and gravelly sand, are clearly outwash materials, sorted and deposited near the shore in temporary bodies of water, and others, as the loam and fine sandy loam, are formed from the reworking of the same kinds of material. Consequently the soils are of lacustrine and semilacustrine origin, certain of the types, as the clay and silt loam, having been formed entirely under water, as is shown by their uniformly fine texture and by stratification planes; certain other types, as the gravelly types, were formed by swiftly moving currents of water, as is evidenced by the cross-bedded and interstratified structure and the coarse character of the materials, gravels and stones; or, in other words, they are derived from the weathering of outwash glacial débris. In still other types, as the loam and fine sandy loam, there is no evidence of water deposition, though it is certain that they were, for the most part, once covered over by glacial waters for longer or shorter periods of time. It is evident, however, that these bodies of water were not of sufficient depth or of long enough duration to effect any amount of deposition, and the resulting soils are the glacial moranic till merely reworked at the surface.

All of these soils are largely of the Dunkirk series, a series of brown and gray, often tinged with red, soils of glacial lake and terrace origin. In this area they range in texture from light sands and gravels to the heaviest deposits of the region, the clay. Ten types of the series are distinguished and mapped in the county, of which the loam, the fine sandy loam, the clay, and the gravelly loam predominate. This series of soils covers one-half of the county, and, taken as a whole, is also the most important agriculturally.

In various parts of this low-level section of the county there are small areas where a considerable amount of organic matter has accumulated on account of poor local drainage conditions, thus giving to the soils a much darker color. These soils belong to the Clyde series, two types being recognized, the loam and fine sand.

In the southwestern corner of the county, in the Portage district and a small part of southeastern Ossian township, is a region belonging to a section of high-level, light-colored lacustrine deposits of earlier geological time. In this section the soils are characterized by light colors, grays, pale yellows, and very light browns predominating. The soils vary from a tough, dense clay to the light, porous sands and gravels. Of this series, the Caneadea, six types are mapped—the

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gravelly loam, the gravelly sandy loam, the loam, the fine sand, the silt loam, and the clay. The silt loam is by far the most important in areal extent. The Caneadea series of soils occurs in its greatest development in the upper Genesee River Valley in Livingston, Wyoming, and Allegany counties of the State of New York.

The soils of this section of the county, like those of the low-level section just discussed, are lacustrine or are modified by lacustrine influences, and all have to do with the various stages of the history of the Genesee drainage and the evolution of the present course of the river which it has taken in postglacial time. Fairchild[a] has recognized no less than seventeen distinct stages or episodes in this drainage. The first three stages involve only the upper part of the valley, and need not be considered in this report. Contemporaneous with stage 4, when the outlet of the Genesee waters was at Cuba, to the Allegheny-Ohio-Mississippi, the formation of the Caneadea series of soils began, and continued through all stages of which the outlet for the waters held back by the ice front and morainal dams was to the south.

During all these stages and in some morainal lakes the soil-forming materials were derived from the wash and erosion of the high shale and sandstone hills of the immediate region, and the resulting soils belong to the light-colored Caneadea series. Upon the recession of the ice front northward successively lower and lower outlets were uncovered, and as soon as the imponded waters were able to drain off eastward and westward farther to the north the soil-forming materials were derived from the mantle of foreign glacial material and the formation of the brown Dunkirk soils resulted. Thus it is seen that the Caneadea series of soils is derived at least very largely from wash from the same materials from which the Volusia series has been derived, while these materials play no important part in the formation of the Dunkirk series.

The stages of Genesee drainage involved in the formation of the Caneadea soils are the fourth, fifth, and sixth and the St. Helena-Gibsonville morainal lake of stage 9. All of the latter stages, 7 to 17, inclusive, were involved in the formation of the Dunkirk soils. Subsequent erosion has greatly modified and altered all of these lake deposits and has been a factor in the processes of formation of all of them, though many of the old terrace levels of the various lakes of the different stages of the development of the present system of drainage are still extant.

The third section of this latter division of Livingston County consists of comparatively recent and present stream-wash and deposition. The soils of this region and formation are of the Genesee series and occupy first-bottom positions. Five types of this series are shown on

[a] Pleistocene History of the Genesee Valley, H. L. Fairchild. Bulletin No. 118, New York State Museum.

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the soil map of the county—the shale loam, the fine sandy loam, the loam, the silt loam, and the clay loam—the silt loam being by many square miles greater in extent than all the other types taken together. These Genesee soils occupy the floor of the Great Valley, the filling at the heads of Conesus and Hemlock lakes, and small stream bottoms in various other portions of the county. They are often overflowed and are still forming by the addition of new materials, as well as by the ordinary processes of weathering, the addition of plant remains, and the action of lower forms of animal life.

Scattered about the county are a few types of soil which do not readily fall within the soil classes and formative processes previously discussed.

A local soil type, the Livingston loam, is the result of residual disintegration of shale rock in place, modified by lake and glacial influences. Other local types are the Honeoye stony loam, which is developed by the proximity of the Onondaga limestone to the surface, the Nunda stony loam, the weathered stony till of the Portage moraine, and the Tuscarora sandy loam, a type derived from sandy lacustrine deposits overlying heavy materials. The Warners loam is due to an accumulation of inorganic materials in fresh water, as Muck and Swamp are due to wet, swampy conditions and an accumulation of organic plant life remains, more or less altered by decomposition. Erosion has exposed the underlying rocks in cliffs and gorges and formed the separation designated as Rock outcrop.

Below is given a table stating the relative and actual areal extent of each series and of each soil type, as shown on the accompanying map of the county:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Dunkirk loam	76,736	19.1	Dunkirk fine sand	3,840	1.0
Volusia silt loam	55,680	13.8	Caneadea gravelly sandy loam	3,840	1.0
Volusia loam	38,720	9.6	Genesee fine sandy loam	3,840	1.0
Dunkirk fine sandy loam	35,840	8.9	Genesee loam	3,392	.8
Dunkirk clay	30,784	7.7	Honeoye stony loam	2,304	.6
Genesee silt loam	26,112	6.5	Swamp	1,920	.5
Dunkirk gravelly sandy loam	22,912	5.7	Caneadea clay	1,280	.3
Livingston loam	13,504	3.3	Rock outcrop	1,280	.3
Dunkirk gravelly loam	12,160	3.0	Caneadea fine sand	1,024	.2
Caneadea silt loam	10,752	2.7	Genesee clay loam	960	.2
Volusia gravelly loam	9,152	2.3	Warners loam	704	.2
Clyde loam	7,488	1.8	Clyde fine sand	640	.2
Dunkirk silt loam	7,360	1.8	Genesee shale loam	640	.2
Warren shale loam	5,440	1.3	Tuscarora sandy loam	320	.1
Muck	5,120	1.3	Nunda stony loam	320	.1
Dunkirk stony clay	4,992	1.2	Dunkirk gravel	320	.1
Caneadea gravelly loam	4,992	1.2			
Caneadea loam	4,160	1.0	Total	402,560	.....
Dunkirk gravelly sand	4,032	1.0			

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DUNKIRK STONY CLAY.

The soil of the Dunkirk stony clay consists of an ash-colored, yellowish-gray or brownish-gray silty clay loam, with a depth of 7 to 9 inches. It is compact and contains a considerable though variable quantity of small to large rounded stones and gravel. The upper part of the subsoil is also more or less silty and gritty, but soon grades into a tough chocolate or reddish-brown, dense, heavy clay or clay loam. The stone content of the subsoil is much less than that of the surface soil. While this description is true of typical areas, there is a phase of the type south of Geneseo where the silty soil covering is not nearly so prominent.

The soil clods badly when handled under unfavorable moisture conditions, either when there is too much or too little water present, and when once plowed under these unfavorable conditions it is almost impossible to reduce the clods and secure a favorable tilth with any amount of tillage. The surface sun-cracks greatly during periods of dry weather.

The Dunkirk stony clay is typically developed north of Geneseo and northwest of Cuylerville, with the nonsilty phase south of Geneseo. There are other areas scattered over that part of the county occupied by the Dunkirk soils. It has a steep, broken to gently rolling topography, and has only a fair surface drainage. However, the fine texture and dense, close structure prevent or retard internal movement of water and make artificial drainage particularly desirable and even necessary in order to insure the best results in the utilization of the type in the growing of the various farm crops. Underdrainage is not only very beneficial in increasing the yields of crops, but also makes possible the satisfactory working of the soil under a much wider range of moisture conditions, reducing the likelihood of clodding, improving the tilth, and making the labor in all the stages of cultivation much more effective.

The Dunkirk stony clay represents altered and weathered lacustrine deposits of a fine character, with an admixture of glacial gravel and bowlders. These sediments were undoubtedly laid down at a time when glacial lakes were prevalent at the ice front. Contemporaneously with the existence of these bodies of water there must have been an occasional inrush of water, floating bodies of ice, etc., all of which must have carried the coarse and stony material now found in the soil. As a rule this type of soil is found at slightly higher levels than the Dunkirk clay and erosion has been instrumental in its formation, the finer materials having been bodily removed, leaving the gritty silt and the hard, stony material more abundant at the surface.

Much of the native timber growth, consisting mainly of white oak, with some elm and beech and a scattering of other hardwood trees,

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has been removed. Remnants of the original forests are found in places. When in sod Canada bluegrass (*Poa compressa*) comes in naturally, giving good pasturage, and the greater part of the area of this soil is in permanent pasture, for which it is well suited. Meadow sods of timothy and alsike clover cut from 1 ton to 2 tons of hay per acre annually. Red clover (*Trifolium pratense*) is seldom planted, though the alsike does well. Forty years ago this soil was used extensively for wheat, of which it produced heavy crops. It was then newly cleared and the wheat was put in among the roots and stumps, the presence of which made the drainage good. It is now less porous, and bakes and clods, making it tough and hard to work. During droughty periods the surface cracks open, the cracks being in many cases an inch or more in width. It is regarded as a poor type of soil for farming. Ten years ago, in 1898, tenants on farms of this type were unable to pay an annual rental of 90 cents per acre. Dairying is coming in, however, and the prospects for the utilization of this soil type are improving. The dairy industry should prove a profitable one for this soil, the stable manure being returned to the soil, increasing the humus content and thus improving the tilth and ease with which it can be handled. However, it is still difficult to rent farms of this soil, so the main use to which it is put is grazing.

The difficulties spoken of make the agricultural conditions of the Dunkirk stony clay poor, though susceptible of improvement by skillful, judicious, and careful methods of soil management. The price of such land ranges from $30 to $40 an acre.

The following table gives the average results of the mechanical analyses of fine-earth samples of both soil and subsoil of the Dunkirk stony clay:

Mechanical analyses of Dunkirk stony clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19393, 19395	Soil	0.9	2.8	2.3	7.2	7.1	41.6	32.9
19394, 19396	Subsoil	.4	2.0	1.8	6.3	7.7	28.6	53.1

DUNKIRK GRAVEL.

The Dunkirk gravel consists of deep beds of coarse rounded gravel. There is at the surface a few inches of material which has a brown color, as a result of the presence of a small percentage of organic matter and a more complete oxidation of the material exposed to the air. Most areas of this gravel type are stratified and bedded, especially in the lower depths, though a few small areas consist of merely

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a mass of unsorted stones and gravel with very little fine material. The stone and gravel of those areas found in the northern part of the county are largely of limestone derived from the Onondaga limestone. In these areas the mass of gravel is often solidly cemented together with carbonate of lime, and almost always the gravels are coated with the same material.

The Dunkirk gravel occurs only to a limited extent. There are several small areas in various parts of the county. All the areas occupy relatively high topographic positions and owing to the open structure and texture are excessively drained. They were formed by water deposits from swiftly moving currents and from morainal deposits. They are poorly suited to farming, owing to the low moisture-holding power. Reforestation would likely be the best use to which they could be put.

DUNKIRK GRAVELLY SANDY LOAM.

The surface soil of the Dunkirk gravelly sandy loam consists of a light, loose, sandy loam from 8 to 10 inches in depth. The color is usually a brown to light brown, though often darker in those fields which are in a high state of cultivation, owing to the presence of a larger amount of decaying organic matter. The sand content is largely of the medium to fine grades. There is also a rather high percentage of fine rounded gravel. The subsoil from 10 inches to 3 feet and more in depth is similar in character to the soil, though usually of a lighter, yellower color, and somewhat less loamy. Often crossbedded and interstratified sands and gravels are found in the subsoil. This soil type is easily cultivated and can be worked under an extremely wide range of moisture conditions, even almost immediately after a heavy rainfall.

Small areas of the Dunkirk gravelly sandy loam are found throughout all of the townships of the county except Portage, Ossian, and Springwater. There are no large areas of the type, though the aggregate areal extent is considerable. The type occupies rolling to almost hilly topographic positions, and owing to this and its loose, open texture and structure has excellent natural drainage.

The Dunkirk gravelly sandy loam is derived from glacial material brought from the north, but has been formed by two different processes. The largest portion of it occurs as delta or temporary lake shore deposits, the material having been washed out from the morainic till and deposited in water. Some of it, however, has been developed by the weathering of the till of small drumlins which probably existed as islands in the glacial lakes held to the south of the ice front as the glacier receded northward by melting. The till of the whole immediate region is especially sandy, and some of these areas

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which have not been modified or where the materials moved by water action are very light in character, have been mapped with the delta and shore formations, the soil characteristics of the two being similar despite their different processes of formation.

The native forest growth of the Dunkirk gravelly sandy loam consisted principally of white pine and chestnut. There was also a scattering of oaks and other varieties of hardwood.

The Dunkirk gravelly sandy loam is well suited to the production of hay, beans, wheat, oats, and early potatoes. Newly seeded areas of clover and timothy yield 2 tons per acre of hay of fine quality. Beans will yield from 10 to 25 bushels, wheat from 16 to 25 bushels, and oats from 40 to 50 bushels per acre. A few alfalfa fields have been sown, with excellent results. The acreage devoted to this legume should be gradually extended from year to year, as the soil is particularly suited to it.

Much of the Dunkirk gravelly sandy loam is topographically unfavorable for agricultural occupation and wooded. These forested areas should be carefully handled on improved forestry principles and as fast as possible not only those areas now covered with worthless second-growth timber, but also other areas unsuited for cultivation should be reforested to chestnut and white pine, which are especially suited to the soil and natural conditions of the type.

The cultivated fields of this type of soil should be liberally supplied with organic matter and maintained in that condition by frequent liberal applications of stable manure and by green manuring. This would not only prove beneficial in improving the tilth, but in increasing its moisture-holding capacity.

The improved areas of the Dunkirk gravelly sandy loam are held at prices varying from $60 to $75 an acre, while the more rough and heavy areas not suited to agriculture are somewhat lower in price.

The following table gives the results of mechanical analyses of a fine-earth sample of both soil and subsoil taken from a field of Dunkirk gravelly sandy loam:

Mechanical analyses of Dunkirk gravelly sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19389	Soil	1.9	7.1	8.1	26.6	19.2	29.0	7.9
19390	Subsoil	2.2	6.4	6.9	27.8	21.3	27.5	7.4

Sample No. 19389 shows 32.5 per cent of fine gravel too large to be included in the fine gravel of the table and sample No. 19390, 29.7 per cent.

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DUNKIRK GRAVELLY LOAM.

The surface soil (interstitial material) of the Dunkirk gravelly loam consists of a loam, light brown to brown in color, with a depth of about 10 inches. The subsoil from 10 to 36 inches is a loam of practically the same texture, the color being deeper and having a reddish or reddish-brown cast. Both soil and subsoil contain a very large percentage of rounded stones and gravel. This stone and gravel content, especially in the northern part of the county, is made up principally of limestone from the Onondaga formation of Devonian age, both the siliceous (or corniferous) and nonsiliceous forms being present. Typical areas of this soil type are best described by the term "stony gravelly loam." Underneath the surface 3 feet is a deep subsoil of stratified and interbedded sands and gravels. Some of these materials are solidly cemented, the cementing substance being carbonate of lime, forming a conglomerate rock. That this subsoil often extends to a considerable depth is shown by sections 30 to 40 feet high.

This soil is quite easily cultivated, though the high stone and gravel content interferes to some extent with the use of the various tillage implements. However, as a rule it is not difficult to secure and maintain a favorable condition of tilth. It can be worked under a wide range of moisture conditions without fear of clodding or puddling, the rock content counteracting tendencies in that direction.

The Dunkirk gravelly loam is most extensively and typically developed in the northwestern corner of the county in Caledonia Township. In fact, it is the predominating soil type of that township. Scattering areas of irregular size and shape occur in various other parts of the county.

The topographic features of this soil type are largely level or slightly undulating, as a consequence of the agencies by which it has been formed. There are, however, some variations from the typical surface features in some of the smaller and less important areas which, occurring on steep slopes, have been greatly modified from their original form. The drainage of the type is good, though some small local areas within the type would undoubtedly be considerably improved in their crop-producing power by underdraining. The beds of sand and gravel of the deep subsoil enable the soil to remove quickly even large amounts of water falling on the surface and to prevent effectively the rise and maintenance of the water table sufficiently near the surface to damage crop growth.

The Dunkirk gravelly loam has been formed by the postglacial weathering and alteration of terrace and delta materials laid down at the ice front by swiftly moving water currents at or about the close of the glacial period. Probably some more recent water movements have been instrumental in a degree in the formation of the type.

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The large area south and southeast of Caledonia is an outwash delta plain, deposited from a large glacial stream whose channel must have been restricted near the present site of the village of Caledonia and its large volume of water forced swiftly through this narrow channel, removing practically all detritus which must have been laid down there by the recession of the ice, and leaving the underlying limestone rock almost bare. Where this outwashed delta plain now exists there must have been a much wider channel, or perhaps a lake, into which the swiftly moving waters flowed. Here, the velocity of the currents being checked, they were no longer able to carry such a heavy load, and deposited it as a delta in the quieter lake water. The other areas of the Dunkirk gravelly loam were formed in much the same manner, swiftly moving water currents being necessary for the carrying and depositing of the stone and gravel content.

Noticeable characteristics of the type are the high limestone content, the lime-cemented gravels previously mentioned, and the fact that most of the stones and gravel are coated with a film of the same cementing material.

The Dunkirk gravelly loam is one of the best corn soils of the county, and with reasonable care and cultivation a maximum crop may be expected annually. The average yield of corn is seldom less than 100 bushels of ears per acre, with a large tonnage of stover for forage. An 8-acre field this season (1908) husked 1,000 bushels, or 125 bushels per acre. Corn for ensilage yields from 8 to 15 tons per acre.

Another important crop adaptation of the type is its suitability for growing the grasses and legumes for hay, and especially red clover and alfalfa. Among the soil conditions favorable for alfalfa may be mentioned good drainage and deep underground water table, lime and limestone content, a structure and texture that will not only permit but aid a rapid and desirable root development, warmth of soil, and, lastly, a high state of cultivation. It is likely that the most essential point necessary to insure success in alfalfa growing is the inoculation of the soil. Successful fields of this valuable legume yield as high as 5 tons per acre and should never fail to produce less than three cuttings annually of 1 ton each per acre. Clover and timothy sod usually yields from 1½ to 3 tons of hay of excellent quality per acre. Certain varieties of beans do well and are extensively grown. The pea bean, the leading variety, yields from 10 to 30 bushels per acre. Oats yield well, usually giving from 40 to 75 bushels per acre. On an average wheat will yield 25 bushels per acre, the usual crop varying from 15 to 30 bushels per acre. Potatoes also do well, the yield ranging from 100 to 250 bushels per acre.

Fertilizers used on the Dunkirk gravelly loam consist of high-grade mineral mixtures and considerable quantities of stable manure,

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as a good many head of cattle, both for dairy and feeding purposes, are kept, as well as many sheep.

Agriculture on farms composed of the Dunkirk gravelly loam is in an exceedingly prosperous condition. But little land is unused, and that under cultivation is farmed well, and not only made to produce good returns, but is maintained in a high state of productivity. The stock kept is of high grade, the fences good, and farm buildings commodious, well built and painted, and in good repair.

Farms of the Dunkirk gravelly loam always bring a high price. A fair average figure is about $70 an acre. Sales vary from $40 to $100 an acre.

The following table gives the results of mechanical analyses of the fine earth of both soil and subsoil of the Dunkirk gravelly loam:

Mechanical analyses of Dunkirk gravelly loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19391	Soil	4.3	11.3	5.9	12.9	12.3	39.3	13.8
19392	Subsoil	2.9	9.3	4.7	12.8	11.9	36.9	21.4

Sample No. 19391 shows 38.6 per cent of fine gravel too large to be included in the fine gravel of the table, and sample No. 19392, 41.9 per cent.

DUNKIRK GRAVELLY SAND.

The soil of the Dunkirk gravelly sand consists of 7 or 8 inches of yellowish-brown to brown gravelly sand, the sand being of a medium to coarse texture and the gravel small to medium and much water-worn and rounded. The subsoil from 7 to 36 inches is a light yellowish-brown to yellow gravelly sand, the sand being somewhat coarser and cleaner than in the top soil and the gravel larger and more abundant. There are small areas which depart from the typical description. In some the gravel is absent and in others it is overabundant. While the surface few feet of the section usually shows no signs of stratification, the lower and deeper section consists of crossbedded and interstratified layers of sands and gravels of various grades, though no very large gravel is found. This soil is easily worked even after heavy rains.

The Dunkirk gravelly sand in this area is rather limited in extent. It is most typically developed and has the largest extent at Mount Morris and between Mount Morris and Moscow. There is also a small area near Sonyea.

The natural drainage of this soil is excellent, the whole section to considerable depths being open and admitting of the free and easy movement of water. It occupies terraces and broad delta plains on both sides of the Genesee River north and south of the High

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Banks. The process of formation which accounts for the occurrence of the Dunkirk gravelly sand in Livingston County is intimately connected with the Pleistocene history of the Genesee River and its valley. These deposits of sand and gravel undoubtedly represent the altered remnants of a series of deltas washed out and built up by successive periods of high water during the progress of the river's work in cutting its present rock-walled canyon, commonly called the "High Banks." None of the type occurs above 900 feet, approximately the altitude of the top of these banks, and none of it below 600 feet, the elevation at their base.

The crops best adapted to the Dunkirk gravelly sand are early potatoes, tomatoes, melons and cantaloupes, string beans, and in fact all kinds of truck and canning crops. The loose, open character of the soil makes it a warm, early soil, and vegetables can be marketed from this type from a few days to weeks earlier than from any of the other soils in the vicinity. The small fruits and berries of all kinds, especially strawberries, do well.

The whole type should be well manured with either stable manure or green crops plowed under, in order to maintain a high content of humus, to aid in holding moisture for the use of the growing crops.

Below is given a table showing the results of mechanical analyses of a fine-earth sample of both soil and subsoil of the Dunkirk gravelly sand:

Mechanical analyses of Dunkirk gravelly sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19387	Soil	4.9	17.3	15.2	21.7	9.1	24.7	7.2
19388	Subsoil	6.1	18.0	15.5	20.6	10.5	22.2	7.3

Sample No. 19387 shows 44.5 per cent of fine gravel too large to be included in the fine gravel of the table, and sample No. 19388, 50.4 per cent.

DUNKIRK FINE SAND.

The Dunkirk fine sand consists of a surface soil of gray to light-brown or yellowish fine sand, extending to a depth of about 12 inches, underlain to a depth of 3 feet and more by a subsoil of yellow fine to very fine sand. Brown colors often occur in both soil and subsoil, but they are not prominent to any great extent. The soil is loose and mellow and especially easy of cultivation.

The occurrence of the Dunkirk fine sand in Livingston County is not general, though small areas are scattered throughout that portion of the county occupied by the Dunkirk series of soils. The topography is variable, ranging from nearly level to hummocky. Drainage is complete, and the native vegetation is uniformly that found on light, loose soils with poor moisture-holding powers.

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The Dunkirk fine sand owes its origin to wash material from the glacial débris of the region and its formation to shore, beach, and stream deposits. The sand is for the most part rounded and water-worn.

Land of this type of soil is much used for potato culture, especially in the northern edge of the county. It is generally given over to the production of the late varieties, whereas it should be devoted to the growing of the early market varieties, to which it is admirably adapted, both in texture and by reason of situation near large markets, leaving the late varieties to the Volusia soils, which are better suited for their production. Potatoes grown on this soil type are almost always given modern methods of care and fertilization, and ordinarily yield about 200 bushels per acre. Alfalfa does well and gives an average of three cuttings of 1 ton per acre each. Corn for ensilage is a profitable crop, generally yielding from 12 to 15 tons per acre. Corn for the grain may yield from 150 to 200 bushels of ears per acre, though the average is probably not over 100 bushels per acre. Beans, the pea variety probably being best adapted to the soil, yield from 7 to 20 bushels, with an average of 10 or 12 bushels per acre. The type is not particularly adapted to grass production, though fairly good crops are obtained, and clover is always used in the rotation immediately preceding the potato crop.

The agricultural conditions on the Dunkirk fine sand are always good, though the areas of this soil are not large enough to remove the influence of other soil types usually included in the farms. The price of choice pieces of Dunkirk fine sand varies from $60 to $85 an acre, according to location, state of cultivation, and condition of improvement.

DUNKIRK FINE SANDY LOAM.

The surface soil of the Dunkirk fine sandy loam is a brown sandy loam with a depth of from 8 to 10 inches. The sand content is mostly of the finer grades, though some medium and coarse sand is present. There is also nearly always some small gravel and stones, but never enough to warrant classing the type as a gravelly loam. The soil is always mellow and friable, though often a rather heavy silty sandy loam. The subsoil consists of a yellowish-brown fine sandy loam, usually somewhat lighter in texture than the surface soil. In it are found some small gravel and also occasional pockets and thin beds of sand and heavy material. In some places there has been an accumulation of organic matter, and the surface soil is consequently darker in color, while the reverse is true of some of the higher lying parts of the type. Around Avon, on the east side of the river, and south of Canawaugus, on the west side of the river, occurs a phase of the type having a heavier subsoil and a

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noticeable percentage of sharp, angular, medium textured sand. An excellent tilth is easily secured in fields of this soil, and it can be handled under a wide range of moisture conditions with safety.

The Dunkirk fine sandy loam is found in Livingston County only in the northern and northeastern parts, it being the predominating soil of the three northeastern townships, Avon, Lima, and Livonia. The type occupies rolling to gently undulating topographic positions, and sometimes extends up over low, rounded hills of the drumlin type. Its elevation varies from a little below 600 feet to about 1,200 feet above sea level, but there is no such considerable change in level in any one restricted locality. The natural drainage of the type is probably the best of any soil of similar extent in the county. Some underdrainage has been done, and more should be done on the more level and more poorly drained fields. The character of the soil itself is such that it can hold a large quantity of moisture and give it up readily to the growing crops as needed. The subsoil also makes an ideal reservoir for storing soil moisture and passing it upward through the soil as the growing crops demand it.

The forces acting in the formation of the Dunkirk fine sandy loam were aqueo-glacial. The soil-forming material is glacial and has been moved considerable distances, the local country rocks contributing but little to it, though a rather high percentage of the stone content is of Onondaga limestone, which outcrops along the northern edge of the county. Practically all of that part of the county where this soil is found has been covered by temporary glacial lakes which existed south of the ice front as it retreated northward at the close of the Glacial epoch. Some of the drumlin hills were probably not covered by these glacial waters, but appeared as small round islands, yet no distinct difference in soil is noticeable. Although this part of the county was subjected to lake conditions, there is in the Dunkirk fine sandy loam for the most part but slight evidence of sedimentation, and instead of true lacustrine soil it is a till soil reworked by shallow waters which did not exist for long enough periods of time to allow the accumulation of sediments.

Of the original forest growth of hardwoods but little now remains, by far the major portion being cleared and used for agriculture. The soil is in fact one of the best in the county.

The Dunkirk fine sandy loam is adapted to a wide range of crops. Alfalfa sown on well-drained areas should prove successful, and failures it is believed can be traced to some cause other than the character of the soil. For this reason the growing of alfalfa on this soil is strongly recommended. Some excellent fields of this legume are now established, producing three cuttings each season of about 1½ tons to a cutting, or 4½ tons of valuable hay from an acre in one season. Corn is also a paying crop for this soil. The elevation is

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not sufficient to make the season too short for the maturing of grain, and the sandy nature of the soil makes it warm and especially suited to this cereal. Yields of from 100 to 200 bushels of ears per acre are reported, with a large quantity of stover in addition. Oats yield from 60 to 70 bushels per acre and wheat from 25 to 35 bushels. One farmer reports that for ten years his wheat crop averaged 30 bushels per acre. Hay will average on good fields 2 tons per acre. Potatoes are grown to a considerable extent and yield from 100 to 150 and 200 bushels per acre, and beans from 20 to 30 bushels per acre. The vine crops, such as cucumbers for pickling and cantaloupes, are especially suited to this soil type.

The proximity of the region in which this soil occurs to the city of Rochester accounts for the extensive development of dairy farming upon it. One-third of the milk supply of Rochester comes from Avon Township, and probably more than 90 per cent of that amount is produced on farms of the Dunkirk fine sandy loam. Many fine herds of thoroughbred dairy cattle are kept, and the type is admirably suited to support this profitable form of farm industry. Much corn for ensilage, clover, alfalfa, and other forage crops are produced in connection with the dairying. Permanent pastures on the type are almost unknown.

The methods in use on the Dunkirk fine sandy loam are the best to be found in the county, and the general farm conditions are excellent. Houses and other farm buildings are usually well painted. The barns are large and the whole home surroundings attractive and well cared for. The fields are well cultivated and intelligently utilized, the quality as well as the quantity of the crops secured being of the best. As a soil type the Dunkirk fine sandy loam probably has but one equal, the Genesee silt loam—excepting the Muck beds—for value and agricultural importance.

The price of farms of this soil type varies considerably. With poor buildings and improvements $60 to $70 an acre would be a fair valuation, and with good buildings and fair improvements it is around $100 an acre.

The following table shows the average results of mechanical analyses of typical samples of both soil and subsoil of the Dunkirk fine sandy loam.

Mechanical analyses of Dunkirk fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19399, 19401.....	Soil.....	1.3	3.9	3.5	15.3	22.2	43.7	10.8
19400, 19402.....	Subsoil.....	2.0	2.7	3.4	14.9	27.6	36.1	9.1

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DUNKIRK LOAM.

The Dunkirk loam is one of the most important soil types of Livingston County, both agriculturally and in areal extent. The surface soil to a depth of 8 or 10 inches consists of a brown to dark-brown loam, always containing enough of the finer grades of sand to make it friable and easy to put in good tilth. Sometimes the sand content is large enough to give approximately a fine sandy loam, though the main characteristics are always those of a loam. In rare instances the sand content of limited areas is low, and clodding takes place if the land is plowed under unfavorable moisture conditions. The subsoil from about 9 inches to 30 inches in depth consists of a light-brown to yellow loam, which becomes sticky when wet. This subsoil also often contains a high percentage of the finer grades of sand, though it usually grows much heavier with the increase in depth. The colors are often mottled, and the subsoil material often contains thin layers of sand and heavy silty clay. Generally at about 30 inches the subsoil becomes much heavier and more dense. This heavier material usually has a reddish-brown color. Though it does not always occur within the 3-foot section, it is seldom absent and exerts an influence upon the overlying material and affects the method of handling the soil and to a considerable extent the crops for which it is used. Both soil and subsoil carry varying quantities of rounded stones and gravel, though never enough to interfere with tillage. Cultivation of this soil type is always attended with satisfactory results, as the sand content is rarely insufficient to insure a mellow, easily worked surface soil.

The Dunkirk loam occurs largely in the central section of the county over a region extending from north to south and is most extensively developed in the townships of Geneseo, Groveland, Mount Morris, York, West Sparta, and Leicester, with the relative area in the order named. It also occurs to a limited extent in the townships of Caledonia, Avon, Lima, Livonia, Conesus, Sparta, Ossian, and Nunda, and not at all in either Portage or Springwater townships.

The topography consists of sloping hillsides to gently rolling uplands. The elevation varies from about 600 to 1,200 feet above sea level, exceeding the latter figures only in Groveland Township. The natural drainage is inadequate, and though the surface is rolling and many small stream courses have been developed, practically the whole type is badly in need of artificial drainage, and no other single improvement would result in as much benefit to the owners and tillers of the land as would this.

The soil-forming material of the Dunkirk loam is of glacial origin and for the most part foreign to the immediate locality. As the glacial ice moved from the north to the south it rode over and ground the surface of many geological formations, carrying along with it

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much of the loosened and softened rock material of each of these formations, and upon its recession northward by melting instead of moving this mass of ice-transported material was dropped where it was, forming a blanket of till of varying thickness over the whole region. Imponded waters from the melting ice and subsequent water agencies have reworked a portion of this till mantle, and the weathered surface of this reworked glacial morainic material forms the soil of the type under discussion.

An interesting and important chemical feature associated with the Dunkirk loam is the fact that a white alkali crust—magnesium sulphate—often forms in low places.

The native forest growth of this soil type consisted principally of black walnut, red oak, elm, and white pine. Until about forty years ago the white pine was the dominant species. It has been followed in nature's rotation with oaks and some hickory. Of the grasses Canada bluegrass and Kentucky bluegrass are indigenous.

The principal crops grown are wheat, beans, oats, hay, and corn. There is also a considerable development of the dairy industry. Beans are one of the money crops, and the average yield from good fields is about 15 bushels per acre, the first choice of varieties being marrows, followed by mediums and kidneys. Wheat is particularly suited to the soil and the production is large, the yield averaging not far from 25 bushels per acre. Oats yield from 40 to 50 bushels per acre. Hay, alsike, and red clover and timothy yield an average of 1½ tons per acre. Corn is grown only to a limited extent for the grain, but to a considerable extent for ensilage in connection with dairying. It furnishes from 10 to 12 tons of ensilage per acre. In the last few years many fields of alfalfa have been sown, and three cuttings, aggregating 4 tons per acre, are secured annually. The judicious extension of the acreage of this legume on well-drained fields is desired. Owing to the particular and delicate adjustment between soil and plant necessary for absolute success in alfalfa culture no sweeping recommendations of its adaptation to Dunkirk loam can be made, but for the man who wisely selects his field on this soil type and fulfills all other necessary requirements success with alfalfa is assured.

Many good farm orchards exist on the Dunkirk loam and the extension of orcharding on a commercial scale, planting varieties of apples, pears, and cherries suited to the soil and its varying conditions, is recommended.

The increasing demand for milk for the Rochester market and the use of the agricultural region and soils nearer that city for the special crops required for that market makes the dairy industry on this soil type of growing importance. There are already many successful dairy farms located upon it. One representative farm of 225 acres devoted to this form of agriculture carries nearly 50 cows and about

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50 head of other stock, only the concentrates and a little hay being bought. In connection with the production of beans a good many sheep are kept to use the dry forage from that crop.

The agricultural conditions existing over all the area of the Dunkirk loam are good, though susceptible of considerable improvement. Suggestions to this end must give, as of first importance, underdrainage, of which practically the whole type is in need. Abundant evidence of the beneficial results of underdrainage in increased yields and profits are at hand and need not be quoted. The extension of alfalfa is probably second in importance, for by its use at least a considerable portion of the concentrated feeds now bought can be produced on the farm and at the same time the condition of the soil improved both through the addition of nitrogen drawn from the air and by increased quantities and richer quality of stable manure secured from the feeding on the farm of the valuable alfalfa hay. The keeping of more stock and the using of better tillage methods and greater care would also aid materially in the permanent improvement of the cultivated fields. And lastly, the reforestation of all those areas least suited to tillage to valuable species of timber trees adapted to the soil, especially the white pine, should be undertaken.

Farms composed of the Dunkirk loam are valued at prices ranging from $50 to $75 an acre, with fair to good improvements.

The following table gives the results of mechanical analyses of fine-earth samples of both soil and subsoil of the Dunkirk loam:

Mechanical analyses of Dunkirk loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19403	Soil	1.0	4.0	4.0	13.6	19.7	45.1	12.5
19404	Subsoil	1.1	4.8	4.1	13.9	20.3	35.2	20.4

DUNKIRK SILT LOAM.

The surface soil of the Dunkirk silt loam consists of 8 to 10 inches of dark-gray to brown silt loam free from stones and gravel, though sometimes gritty from the presence of a very small admixture of sand. It is mellow and friable, though usually compact. The subsoil to 36 inches is a light-brown or yellow compact silt loam in which the fine sand content is sometimes quite high and which may contain lenses and pockets of heavier material. Gravel and stones are noticeably absent. This soil can be worked into good tilth, but care must always be exercised to see that plowing and subsequent cultivation are done when the moisture content is favorable for such operations or clodding is likely to result.

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The Dunkirk silt loam is found scattered throughout Livingston County, except in the region occupied by the Genesee and Volusia soils. The largest and most typically developed areas are in Avon Township southwest of Avon. The topography is undulating to rolling, but nevertheless the natural drainage is unsatisfactory, the compact structure and close texture preventing the free movement of soil moisture within the soil. This soil is capable of caring for a considerable moisture content, but it requires only a little excess to water-log it, and then the growing crops not only suffer from too much water, but necessary tillage is delayed or prevented and crop failure or damage ensue. The artificial drainage of practically the whole area mapped as Dunkirk silt loam is recommended.

The material from which the soil of the Dunkirk silt loam has been formed is derived from some of the finer glacial débris, and the deposition of this material in the comparatively quiet waters of temporary glacial lakes accounts for its present position. The surface has been altered by the natural soil-forming agencies, oxidation, aeration, the action of plant and animal life, humification, and the combined chemical changes thereby induced. While these changes have been more or less active near the surface, the subsoil has been but little altered in this respect, owing to the physical characteristics of the type.

The native forest vegetation consists of elm, white oak, and some beech, while among the grasses Canada and Kentucky bluegrass predominate, followed by meadow fescue, timothy, and the clovers.

The Dunkirk silt loam is well suited to the production of the small grains, and grasses for hay and pasturage. A good sod ordinarily yields from 1 ton to 2 tons of hay per acre. Wheat will average about 20 to 30 bushels and oats from 35 to 50 bushels per acre. This type of soil is poor for corn and potatoes, though somewhat better for both than its companion type, the Dunkirk clay. Alfalfa should succeed on the Dunkirk silt loam, but great care must be given to the drainage and other features necessary to insure success in the growing of this legume before any attempt is made.

The average price of land of this soil type would probably not be far from $40 to $50 an acre.

The following table gives the results of mechanical analyses of a typical sample of both soil and subsoil of the Dunkirk silt loam:

Mechanical analyses of Dunkirk silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19405	Soil	0.2	1.2	0.4	4.8	19.8	64.4	9.1
19406	Subsoil	.0	.3	.1	1.2	25.1	64.2	9.0

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DUNKIRK CLAY.

The surface soil of the Dunkirk clay to a depth of from 6 to 8 inches consists of a light-brown to reddish-brown heavy clay loam or clay, or a gray to yellowish-brown silty clay loam, with a much darker color, approaching black in many of the low places, and lighter brown colors prevailing on the higher spots. The subsoil underlying this and usually extending to a depth of many feet is a reddish-brown to chocolate colored clay. The subsoil is plastic, stiff, and very tenacious. Below the surface few inches, which has been altered by cultivation and plant-root growth, the whole section shows not only bedding or stratification structure planes, but also vertical structure or joint planes. If a solid handful of this material be slightly twisted by a movement of the fingers it falls apart into larger or smaller pieces or granules. While the surface soil varies from a silty clay to a heavy clay the subsoil is always found to be uniformly heavy, dense, and tenacious.

The cultivation of the Dunkirk clay is attended with much labor, many vexations, and often unsatisfactory results. It must be handled when the moisture content is just right, and stirring at any other time is a fatal mistake. The limit in moisture conditions favorable for the mechanical tillage operations is very narrow. If it is only a little too wet or a little too dry, plowing results in large and small clods, which no amount of time and labor spent in subsequent cultivation can reduce, and consequently the feeding surface for plant roots is reduced practically to a minimum. Not only this, but also a large amount of surface is exposed to the air, and the loss of soil moisture, which should be retained for the plants to feed upon by evaporation, is proportionately large. However, if cultivation takes place under optimum moisture conditions, it results in a favorable tilth and much greater returns with a smaller expenditure of labor and time. The surface sun cracks badly during droughts. These cracks are often wide enough to admit a man's hand and extend downward a foot or more.

The Dunkirk clay is one of the most extensively developed types of soil in the county. Large areas occur on the east side of the Genesee River north of Geneseo in Geneseo and Avon townships and in the southeastern corner of the township of Lima. On the west side of the river there is a single area, north and south of Piffard and Retsof, which covers a number of square miles. There are extensive areas all along the southwest side of the Great Valley from its head at Dansville to the vicinity of Mount Morris. In this region it also extends up the Keshequa Creek Valley as far as Nunda Junction. There are several other small areas, the largest being between Groveland Station and Scottsburg.

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The topographic features of the type are varied. The two large areas on the east and west sides of the Genesee River occupy, in part, a series of high terraces. The topography of these two areas is level to gently rolling, the elevation being from 560 feet, about the level of the first bottoms of Genesee silt loam, up to about 750 feet above sea level. The topography of the area southeast of Lima consists of terrace plains, somewhat eroded, along the Honeoye Creek. The elevation of these terraces varies from 780 to 940 feet. Those areas southwest of the Great Valley are more broken and rough from the effects of erosion, though some of the terraces are still distinct and some nearly level or undulating to slightly rolling areas are found. The elevations in these areas show much wider variation, especially in the maximum extremes. The lower limit is about 580 feet, while the upper limit in some cases is as high as 1,200 feet above sea level.

The drainage features of the Dunkirk clay are among the poorest of any soil in the county. Water falling on the more level areas has little opportunity to escape except by evaporation. Stream courses are few and lateral moisture movements within the soil itself are effected only with difficulty, and at the best very slowly. Seepage downward is likewise slow and difficult on account of the extreme fineness of the soil particles and their close, compact arrangement. Where the more silty soil covering occurs the moisture is held as if by a sponge. Even where the surface is broken by erosion drainage is poor on account of the inability of the soil to move moisture rapidly. This imperviousness to water is one of the most important factors in limiting the time favorable for plowing.

Tile drainage would be of great benefit over practically all of the type. The drains should be placed near together and not too far beneath the surface. Drainage such as this would be expensive to install, but the fact that in such a soil the effectiveness of the drains, if properly laid, would increase from year to year and do more and better work after they had been put down thirty and forty years than at any previous time would be a compensating advantage not to be overlooked. Looking at the matter in this light, the original cost is not so high as it would seem at first thought.

A second factor having to do with the mechanical condition of this soil and the limits within which it can be handled, and closely connected with the amount of moisture it can absorb, retain, and deliver to the growing crops, is its organic matter or humus content. As a whole, the Dunkirk clay carries a low percentage of organic matter, and that which it does contain is largely confined to the surface few inches. An increase in the amount of this material, either by the liberal application of stable manure or by the turning under of green crops, would not only improve the tilth of the soil but enable it to carry a larger quantity of moisture in the form useful to plants.

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The Dunkirk clay is formed from the heaviest lacustrine deposits of the region. It is evidently the deepest Pleistocene deposit laid down during Glacial times now exposed. When the glacial ice was receding northward various bodies of water were held at its front, which received not only the waters of the drainage from the south, but a large volume of water from the melting ice. In the case of this particular soil at least, the larger part of the sedimentary materials were carried by and deposited from the waters of the receding ice field, as the character of the material indicates that it came from regions to the north of the area in question. Its occurrence at various levels is accounted for by the fact that, as the ice front retired northward to the lower country, successively lower and lower outlets for the imponded bodies of water were uncovered, each terrace level representing different temporary halts in the process, the waters remaining at these levels for longer or shorter periods of time. At least seven of these stages have been recognized, affecting the area of Livingston County, where this soil type is found. The elevation of the outlets of these lake waters vary from 1,200 feet down to 660 feet above sea level. Some of the terrace levels found in areas of Dunkirk clay correspond exactly with the height of these various outlets, though subsequent erosion, which has been instrumental in developing the present configuration of the surface features of the type, has in various places obliterated the original levels.

In the chemistry of the Dunkirk clay there are two interesting and important facts, one of which raises an important and apparently new question in eastern agriculture. The first of these facts has to do with the lime content of the formation. Laboratory analyses of both the soil and the subsoil of a typical sample showed 9.52 per cent of lime—calcium carbonate (CO_2 calculated to $CaCo_3$)—in the subsoil from 6 to 36 inches, while the surface soil to a depth of 6 inches was entirely devoid of lime. The second fact is the presence of alkali—magnesium sulphate—an occurrence extremely rare in the humid East.

The original native forest, some of which remains standing, consisted chiefly of white oak and elm, with some beech. The native or permanent sods are spoken of as "bluegrass," the term here meaning the Canada bluegrass (*Poa compressa*). The following table gives a three-year count of the herbage on the same section of field in permanent sod, and can be considered representative for land seeded for twenty years and more and not badly eroded:

	Per cent.		Per cent.
Canada bluegrass	22	Orchard grass	4
Kentucky bluegrass	23	Red clover	10
Meadow fescue	15	White clover	10
Timothy	10	Alsike clover	4

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In seeding of more recent origin, say less than ten years, and where the percentage of organic matter in the soil is lower, the Kentucky bluegrass, meadow fescue, timothy, and red clover are not present in such large proportion, the herbage consisting of Canada bluegrass, oxeye daisies, white clover, and miscellaneous weeds. Later the Kentucky bluegrass comes in, being followed by meadow fescue, the latter being more particular in its soil requirements. This last statement is well illustrated in a permanent pasture of long standing on the west side of the river north of Piffard. Some of this large pasture has never been cultivated.

The Dunkirk clay in its present condition is peculiarly suited for permanent pasture, from 80 to 85 per cent of its area being utilized for that purpose. It is highly esteemed by grazers in finishing cattle for market, but not for growing them. Cattle are turned into the pastures about June and can be kept there until about November 15, or five and one-half months. Ordinarily it requires from 3½ to 5 acres to furnish grazing for one steer, which will make a gain of from 300 to 400 pounds during the season. Probably next to pasture the most extensive and important use of the type is in the production of hay. The meadow sods are principally of Canada bluegrass and Alsike clover, and give an average yield of 1 ton per acre. Alsike clover for seed usually produces about 6 bushels per acre. In the last few years some alfalfa has been put in upon this soil type and promises excellent results, notwithstanding the heavy character of the soil. Success with this valuable leguminous forage crop is possible, it is believed, with such a soil on account of the peculiar structure previously mentioned, which permits the roots to penetrate the lower depths in spite of the fineness of the soil particles and its generally heavy character. Without this structure the soil would be heavy enough to prevent the deep-root development necessary for success in alfalfa culture. The high percentage of carbonate of lime in the subsoil is also a favorable factor.

Three cuttings of alfalfa were secured from these fields the past season (1908), averaging 1½ tons per cutting, or 4½ tons per acre. However, the utmost care and judgment must be exercised in the management of this soil if alfalfa growing is to be successful.

Wheat was formerly much grown on the Dunkirk clay, but in recent years the yields have fallen to such low levels that its use for the production of this cereal has practically ceased. Yields in the past have been as high as 30 bushels per acre, but now only about 15 bushels per acre can be expected.

Oats are usually heavy, though only occasionally grown. They yield from 40 to 50 bushels per acre.

This soil is considered especially poor for corn and potatoes and they are not produced to any extent upon it.

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The general agricultural condition of the Dunkirk clay is not as good as it might be made. The extreme difficulty in managing the soil in anything but sod and the bad reputation it has obtained for wheat production have a far-reaching effect upon the agricultural possibilities of the type. If the growing of alfalfa proves a success, as it now promises to do, the greatest step possible in improving these conditions and showing the inherent possibilities of the soil has already been taken, and the market value and regard for the type must necessarily increase.

The selling price and assessed valuation of the Dunkirk clay are about the same, the figures varying from $30 to $40 an acre.

The following table gives the average results of mechanical analyses of typical samples of both soil and subsoil of the Dunkirk clay:

Mechanical analyses of Dunkirk clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium. sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19407, 19409.....	Soil.....	0.0	1.6	1.0	4.2	3.4	46.2	43.5
19408, 19410.....	Subsoil.....	.2	.9	.8	3.6	5.0	27.8	62.2

The following sample contained more than one-half of 1 per cent of calcium carbonate ($CaCO_3$): No. 19408, 9.52 per cent.

CANEADEA GRAVELLY LOAM.

The soil of the Caneadea gravelly loam is a light to dark brown gravelly loam, rounded stones and coarse gravel being particularly abundant, though there is also present a considerable percentage of the finer grades of gravel. The interstitial material is usually light and contains much of the various grades of sand. This surface soil is about 7 inches deep. The subsoil, from 7 to 36 inches in depth, consists of a yellowish-brown to ocher-colored gravelly loam, grading in its lower depths to nearly pure gravel. Generally the subsoil contains much less fine material than is present in the surface soil, though coarse sand is plentiful. The deep subsoil consists of stratified beds of gravel and sand, usually to depths of many feet. For the most part all of this gravel is rounded, though in some areas there are flat fragments of fine-grained sandstones and shales. The gravel content does not interfere with cultivation, and a good seedbed can always be made, even under a very wide range of moisture conditions.

This soil type occurs in the southwestern corner of the county, in the Portage district. There is also a considerable area around Ossian and in the southeastern corner of Ossian Township, in the upper Canaseraga Valley.

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The topography is generally level to slightly undulating, the elevation being from 1,200 to 1,300 feet above sea level. The natural drainage is good and even excessive, owing to the loose open structure of both soil and subsoil and the underlying gravel beds.

The materials from which the Caneadea gravelly loam has been formed were laid down from swift-moving water currents in glacial lakes.

The Caneadea gravelly loam is devoted to general farm crops, of which the yields are usually satisfactory, though often curtailed by drought. Indian corn usually averages from 50 to 60 bushels per acre, with a possible yield as high as 75 to 100 bushels per acre. Oats will yield from 25 to 60 bushels, with an average of 35 to 40 bushels per acre. Wheat will make from 12 to 20 bushels per acre. Potatoes yield from 100 to 150 bushels per acre. Hay will average from 1 ton to 1½ tons per acre. Alfalfa should be successfully grown, at least on some fields.

The conditions prevailing on this soil type are fair, and susceptible to considerable improvement. The selling price of the lands varies with both location and character of the buildings and other improvements. Poorly located areas, with poor buildings, etc., will bring about $25 an acre, while the better located areas with buildings in better repair and with better improvements readily sell at $50 to $60 an acre.

The following table gives the results of mechanical analyses of fine-earth samples of both soil and subsoil of the Caneadea gravelly loam:

Mechanical analyses of Caneadea gravelly loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19415	Soil	9.6	21.5	8.4	9.6	13.5	29.8	7.9
19416	Subsoil	8.1	27.3	12.3	10.4	13.5	20.4	7.7

CANEADEA GRAVELLY SANDY LOAM.

The soil of the Caneadea gravelly sandy loam consists of a light gravelly sandy loam, brown to yellowish brown in color, and with a depth of 7 or 8 inches. The gravel content is large and is made up of fine rounded gravel and small stones. Fine to medium sand is present in considerable quantities. The subsoil to a depth of 36 inches is a yellowish-brown to yellow sandy loam having about the same gravel and stone content as the surface soil, the stones, however, being somewhat larger in size. In both soil and subsoil the sand may be mainly medium to coarse in texture, this being particularly true of the subsoil. This type of soil is easily worked, even soon after heavy rains, and no serious difficulty is experienced in

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obtaining a good tilth and good results from all operations of subsequent cultivation.

The Caneadea gravelly sandy loam occurs in Livingston County only in the region of Nunda and Portage, in the southwestern corner of the county, with some smaller areas in southeastern Ossian Township. By far the largest areas and nearly all of the type is found in Portage Township. The surface features of this soil consist of nearly level plains to steep broken slopes, which, together with open texture and structure, insures an adequate surface drainage. In fact, drainage is almost too free, especially where the formation from which the type is formed is of considerable depth.

The Caneadea gravelly sandy loam, like the lighter types of the series, is the result of the deposition of sands and gravels with some finer material in a former high-level glacial lake.

The native forest growth originally consisted principally of chestnut and white pine. The pine has all been removed, the stumps now forming many of the fences of the region. The original chestnut growth has also been cut off, and in many places a second growth has sprung up, making valuable timber for fence posts, cross-ties, and telephone and telegraph poles.

The Caneadea gravelly sandy loam is well adapted to the production of early potatoes, strawberries, raspberries, blackberries, beans, and the vine crops, such as melons and cucumbers. The crops now grown, with the yields ordinarily secured, are: Corn, an average of 75 bushels, with a possible maximum of 125 to 150 bushels per acre; potatoes, an average of 100 to 200 bushels, with maximum yields of from 150 to 300 bushels per acre; wheat, from 12 to 25 bushels; beans, 10 to 25 bushels; and oats, from 30 to 60 bushels per acre. Mowing lands of timothy and clover yield well, varying from 1 ton to 2½ tons per acre, according to the age and condition of the sod.

Dairying is probably at present the principal line of farming on the type. Hops were formerly grown to a considerable extent, but in recent years have been entirely superseded by other crops. Alfalfa thrives in the few fields where it has been planted, and its extension is both practicable and advisable.

The farm conditions prevailing on this type of soil are good where the topography is favorable for agricultural occupation. Areas less suited to crop production are covered by more or less worthless timber growth, except for the second-growth chestnut. The price of farm land of the Caneadea gravelly sandy loam ranges from $50 to $60 an acre. The forested areas sell for a somewhat smaller price, depending almost entirely upon the stand and character of the timber growth.

The table following gives the average results of mechanical analyses of typical samples of the fine earth of both soil and subsoil of the Caneadea gravelly sandy loam.

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Mechanical analyses of Caneadea gravelly sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19411, 19413	Soil	1.6	11.1	11.4	24.3	21.5	23.8	6.0
19412, 19414	Subsoil	4.7	17.4	11.6	20.3	12.7	23.1	9.5

CANEADEA FINE SAND.

The Caneadea fine sand consists of about 10 inches of a light-brown to yellow very fine sand, with a yellow fine sand subsoil. This subsoil is slightly more loose and incoherent and also a little coarser than the surface soil. It extends usually to a considerable depth.

This type of soil is found only in the southwestern corner of the county in Portage Township. Its extent is small, but the areas are nearly always level to gently rolling and generally well drained.

The occurrence of the type and the processes of its formation are due to the former existence of a high-level lake held in the upper Genesee River Valley by the glacial ice and morainal dams.

The Caneadea fine sand is not much cultivated, the largest area of it being unused for agriculture. It is loose and light and sadly deficient in organic matter. Its best use would be in the production of the light and early truck crops for local markets. With care to increase the humus content and to maintain it, fair yields of these crops should be secured.

The following table gives the results of mechanical analyses of an average sample of both soil and subsoil of the Caneadea fine sand:

Mechanical analyses of Caneadea fine sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium. sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19417	Soil	0.4	3.2	4.0	26.5	37.0	23.1	5.7
19418	Subsoil	.4	2.1	3.8	31.4	39.4	18.5	4.2

CANEADEA LOAM.

The surface soil of the Caneadea loam to a depth of 8 or 9 inches consists of a mellow, fine loam, yellowish-brown in color, containing a small percentage of fine shale fragments and rounded gravel. The subsoil, to a depth of 36 inches, is a mellow loam. The stone content of the subsoil is low. The prevailing color of the section from 9 to 30 inches is a yellowish brown to ocher, being almost exactly the color of ginger. Often in the lower depths of the section a mottled yellow and brown or drab color is found. In both soil and subsoil are pock-

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ets and lenses of fine and very fine sand, commonly called "quicksand." There are sometimes, though these are not so common, deposits of heavy material.

This type of soil is friable and easily worked, a good tilth being secured with a minimum amount of labor. The Caneadea loam occurs only in the southwestern corner of the county in Portage and Nunda townships, with a few scattered areas in the upper Canaseraga Valley of southeastern Ossian Township.

The topography is nearly level to gently rolling, and the areas are always found at relatively high levels, the elevation being from about 1,100 to 1,600 feet above sea level.

The natural drainage is good, though probably underdrainage would be of benefit to some of the more level portions of the type. The moisture conditions are favorable, as the fine texture provides a reservoir for the absorption and storage of a maximum proportion of the rainfall. These characteristics practically insure crops from damage by excess of water and also, through the easy and free movement of the ground water and soil moisture, enable the soil to tide the crops over extended periods of drought.

The Caneadea loam represents the weathered product of shallow-water deposits derived chiefly from the country rock of the higher lying shale and fine sandstone hills of the immediate region. While much of the soil-forming material is water deposited, there is also evidence that the reworking of morainic till deposits has contributed largely to its formation.

The native timber growth of the type consisted largely of white pine and chestnut. There are at present some valuable groves of second-growth chestnut suitable for fence posts, railroad cross ties, and telephone and telegraph poles. In unimproved areas blackberry and raspberry bushes grow luxuriantly.

The Caneadea loam is a good general farm soil and is also well adapted to the production of some of the special crops. It is particularly adapted to the growing of strawberries, blackberries, raspberries, both red and black, and other small fruits. It should also prove very profitable in the production of the vine crops, such as cucumbers for pickling, melons, squashes, etc. Of the general farm crops it would seem to be best suited to potato culture. This crop is unusually successful, ordinarily yielding from 150 to 250 bushels per acre. The minimum yield is seldom less than 100 bushels and the maximum may be 250 bushels, or even more, per acre. Corn will produce from 60 to 75 bushels per acre, with a possible maximum of 100 to 125 bushels per acre, though the greater part of the acreage devoted to this crop is utilized for ensilage in connection with dairy farming. Oats yield from 40 to 50 or 60 bushels per acre, wheat from 12 to 25 bushels, beans (yellow eyes) from 12 to 20 bushels, and

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hay from 1½ to 2½ or 3 tons per acre. Red clover does well and alfalfa is successful, generally yielding three cuttings of an average of about 1 ton each per acre.

The principal farm industry practiced on the Caneadea loam is dairying, there being cheese factories and creameries near at hand to manufacture the finished products derived from the soil—butter and cheese.

The general condition of agriculture prevailing on areas of this soil type is better than the average, farm buildings are commodious, well painted, and well cared for, the fields are well cultivated and in a good productive state, and the home surroundings generally neat and tidy.

The price of farms of the Caneadea loam varies from $40 to $100 an acre, the higher price being for small acreages near towns and shipping points, with good buildings, and the lower price for larger acreages with poorer improvements, situated more remote from towns and shipping points.

The following table gives the average results of mechanical analyses of fine-earth samples of both soil and subsoil of the Caneadea loam:

Mechanical analyses of Caneadea loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19419, 19421	Soil	0.8	3.2	3.9	14.1	12.9	46.6	8.3
19420, 19422	Subsoil	1.3	3.0	3.3	12.4	25.5	46.6	7.6

CANEADEA SILT LOAM.

The surface soil of the Caneadea silt loam consists of a pale-yellow to gray or grayish-white silt or silt loam to a depth of 9 or 10 inches. The subsoil to 36 inches in depth is a pale-yellow to yellowish-brown or light-drab silt or silt loam, which in the lower depths sometimes becomes mottled and often tends toward a silty clay loam in texture. Practically no stones or gravel are ever found either in the soil or subsoil, though there is often a considerable quantity of gritty material present. The type is soft and easily eroded and in steep unprotected places it often washes and gullies badly. When dry the surface is light gray to nearly white in color, which has given rise to the local name "white muck." It is as a rule easily cultivated and handled under a wide range of conditions, with a fair amount of time and labor expended, though some difficulty is experienced with clodding when handled under unfavorable moisture conditions.

The Caneadea silt loam is found in Livingston County extensively and typically developed from the High Banks near Mount Morris up the Genesee River on the northwest side to the Wyoming County line,

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and on the southeastern side to the Allegany County boundary line, and has been observed on both sides of the river in both of these counties farther up the river. Some smaller areas occur in other portions of the southern end of the county.

The topography of this soil type varies from flat-topped terrace plains to gently rolling and steeply sloping areas. Its elevation varies from about 900 to 1,400 feet above sea level. The natural drainage is fair, though it could be much improved by under-drainage.

The Caneadea silt loam is the most extensive of the high-level glacial lake deposits of the county. It represents some of the finer deposits in these temporary lakes held by the ice front or by moraines. Later weathering, erosion, and other modification of these fine silt sediments have formed the soil type as it now exists.

The forest growth consists chiefly of white oak, with some black and red oak and hickory. Originally there was some white pine where the soil is of a lighter phase. The natural sod consists of Canada bluegrass and white and alsike clover.

Probably the best utilization of the Caneadea silt loam lies in the production of hay to be fed on the farm in connection with dairying or stock raising. By practicing this type of farming the organic matter content of the soil can not only be maintained but increased, for necessarily some concentrated feeds will be purchased which will increase both the quantity and fertilizing value of the stable manure to be returned to the soil. The increasing of the organic content of this soil is particularly desirable. Though corn for grain is not a crop especially suited to the soil, its production for ensilage in connection with dairy farming is desirable, thus providing forage for a larger herd of cows than could otherwise be kept, and correspondingly increasing the supply of organic matter in the form of stable manure.

The Caneadea silt loam is a natural bluegrass (Canada) soil, making good pasture sod for grazing, and is well suited to the growing of timothy of high quality and alsike clover for hay. Mowing lands yield from 1 ton to 2½ tons of hay per acre. Corn will yield from 30 to 75 bushels of ears per acre, wheat from 12 to 18 bushels, oats an average of 25 to 40 bushels, and beans about 12 bushels per acre. Potatoes are a poor crop, the soil not being at all suited to them, and they should not be grown except for home use. Some seasons they are a complete failure, scarcely returning the seed planted, and as a maximum yield usually not more than 75 bushels per acre can be expected. Beans will not usually pay the cost of production. A few alfalfa fields are doing fairly well, giving three cuttings per season, averaging 1 ton per acre at each cutting.

The number of sheep kept substantiates the statement previously made that the type is best suited to some form of animal husbandry.

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The general agricultural aspect of the Caneadea silt loam is only fair. The appearances seem to indicate that agriculture is not advancing as it might, but, on the other hand, that it is slowly declining. This should not be so, as the soil is capable of supporting better forms of agriculture if it is properly managed.

Land values for the Caneadea silt loam are lower than they should be. The selling price of the type varies from $15 to $35 an acre, which in many cases would no more than pay for the improvements, and in most cases would not replace them.

The following table gives the average results of mechanical analyses of representative samples of both soil and subsoil of the Caneadea silt loam:

Mechanical analyses of Caneadea silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19423, 19425	Soil	0.0	1.0	0.6	1.2	2.1	76.8	18.1
19424, 19426	Subsoil	.0	.3	.3	.8	1.2	74.9	22.4

CANEADEA CLAY.

The surface soil of the Caneadea clay is a heavy, gray to drab silty clay, grading at from 4 to 6 inches into a drab to brown, dense, plastic, tough clay, which in turn passes into a mottled yellow and drab clay in the lower part of the section. The whole section of this soil type has a fine, close texture, and a dense, compact structure. In many places the bed rock of shale or sandstone is encountered within the 3-foot section, and where this shallow phase occurs there is a considerable quantity of flat, angular shale or sandstone fragments present. However, in a typical section no rock is found, either in place or as broken fragments. The soil is difficult to handle. It can be properly plowed and cultivated only within a narrow range of moisture conditions, for if even a little too wet or a little too dry it breaks up into clods which are reduced by subsequent cultivation only with great difficulty, if at all. If plowed under unfavorable conditions of moisture, it may be that a few hours of hard but injudicious labor will result in ruining the field for the season.

The Caneadea clay is found in Livingston County only in the southwestern corner, in the townships of Nunda and Portage. It is not of large extent, though decidedly marked in its type characteristics. Its topography is rolling but not hilly. Surface drainage is good, but internal moisture movements are slow and inefficient. Underdrainage would be of great benefit, though expensive and difficult, for owing to the slow movement of water through the soil the drains would have to be placed close together.

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The occurrence of the Caneadea clay and its method of formation are accounted for by the fact that during the recession of the glacial ice which once covered the region a temporary lake was formed to the south of the ice front. In this glacial lake were deposited sediments of various texture, the weathering of the heaviest of which has formed this type of soil. Where this deposit was thinnest over the country rock or where it has since been largely removed by erosion is found the shallow phase of the type.

The Caneadea clay is largely in permanent sod, either for hay or pasture, for which it is best suited. Timothy hay does well, and makes a crop of excellent quality. Alsike and white clover are better suited to this soil than the red clover on account of their shallow root development, the former in sod for the hay crop and the latter in permanent sod for pasturage. Good mowings will cut on the average from 1 ton to 2 tons of hay per acre. Some buckwheat, beans, and corn are grown, but the extensive use of the type for cultivated crops is not to be advised. But few farm homes are situated on the Caneadea clay, and the price of farm lands range from $20 to $40 an acre only.

The following table gives the results of mechanical analyses of a typical sample of both soil and subsoil of the Caneadea clay:

Mechanical analyses of Caneadea clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19427	Soil	0.0	1.0	0.6	2.6	2.3	48.4	45.1
19428	Subsoil	.2	1.4	1.4	3.4	3.2	26.5	64.3

VOLUSIA GRAVELLY LOAM.

The surface soil of the Volusia gravelly loam to a depth of about 7 inches consists of a very light brown loam, more or less filled with angular fragments of both sandstone and shale and small to large rounded gravels. The subsoil is a yellowish brown to brown light loam containing a large amount of shale and sandstone fragments and rounded gravel, all of various sizes and shapes. It is usually lighter, both in color and texture, than the surface soil and the gravel content is higher and increases with the increase in depth. This type of soil is easily cultivated. It is the warmest, earliest type of the series.

The Volusia gravelly loam occurs in rather small, scattered areas throughout the region occupied by the Volusia soils in the southern end of the county, principally in Nunda, Ossian, Sparta, and Springwater townships. The topography is rolling to hilly. Its elevation is somewhat more than 1,200 feet above sea level. The drainage is usually good compared with that of the silt loam of the same series, with which it is associated.

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The Volusia gravelly loam is derived from the weathering of gravelly morainic material, and to some extent from local wash deposits from the same material.

The native vegetation consisted of beech and sugar maple, with some oaks and white pine. Most of this native timber was removed long ago and the forests now found are chiefly of second growth and at present of value only for firewood, with a small amount of lumber for farm use.

The Volusia gravelly loam is the best type of the series for the production of corn. Its free natural drainage and gravelly character make it warmer and earlier than either the loam or the silt loam, and also insure a more rapid growth to maturity. It is also suited to the production of oats, beans, clover, etc.

Hops were formerly extensively grown on the Volusia gravelly loam in Nunda Township and yielded about 1,000 pounds an acre. The first commercial crop of hops grown in the county was produced on this soil type between Barkertown and Nunda about fifty years ago, and the last commercial crop was produced during the past season (1908) on the same farm and on the same soil by a son of the original grower. This last hop yard, consisting of 7 or 8 acres, is to be plowed up and the owner of the farm will devote his energies and soils to dairy farming.

The following table gives the results of mechanical analyses of the fine earth of a representative sample of both soil and subsoil of the Volusia gravelly loam:

Mechanical analyses of Volusia gravelly loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19445	Soil	6.6	8.9	3.2	5.6	8.1	49.4	18.2
19446	Subsoil	7.3	10.3	4.2	6.5	11.3	43.8	16.8

VOLUSIA LOAM.

The soil of the Volusia loam to a depth of 8 or 10 inches consists of a slightly yellowish-brown to gray loam containing a rather high percentage of fine sands and silt. While the colors mentioned are the predominating ones, areas which are in a good state of cultivation have a darker, warmer color, and, on the other hand, the soil of fields in a poor state of cultivation is characterized by a lighter, more yellow, and inert appearance. The subsoil from 10 to 36 inches is a fine sandy silty loam, yellow to yellowish brown in color. Both soil and subsoil contain a varying but generally large content of flat, angular shale and fine-grained sandstone fragments of various sizes. Where the fine-grained sandstone or arenaceous shales are most nu-

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merous, the fine sand content of the whole section is noticeably higher and often streaks of nearly pure sand are found in the lower part. Where the finer, more argillaceous shales occur more largely the texture is less sandy and more silty. Often the stone content is especially high in the lower part of the section. This soil is usually mellow and friable and works up into excellent tilth where a reasonable amount of time and labor is expended in cultivation.

The Volusia loam occurs only in the southern and southeastern parts of the county in the high hill country. It is most extensively developed in Conesus, Sparta, and Springwater townships. There is one large area lying on the flat top of a hill northwest of Nunda, in Nunda and Mount Morris townships, and smaller, scattered areas in the other southern townships, West Sparta, Portage, and Ossian.

The topography of the Volusia loam, like that of the Volusia silt loam, is rolling to hilly. It rarely occurs below an elevation of 1,200 feet above sea level. The natural drainage, while generally much better than in case of the silt loam, could, as a rule, be considerably improved by artificial means. The high stone content makes favorable conditions for internal moisture movements.

The Volusia loam owes its origin to the weathering of a mantle of glacial material in place. This deposit of till is like that from which the Volusia silt loam is derived, except that, as a rule, it is thicker, more friable, and has a greater stone content. This mantle of till is largely derived from the glaciation of the local country rock, with the addition of a comparatively small percentage of foreign rock material. The soil-forming material has not been moved any considerable distance, but was deposited near its original position by the glacial ice upon its recession as a ground moraine, with occasionally small local lateral moraines and moraines of recession.

The arenaceous character of some of the Chemung rocks which constitute the high hill country of that portion of the county where the Volusia loam occurs accounts for the more sandy texture of the soil and the formation of a loam rather than a silt loam.

The native forest growth of the Volusia loam consisted chiefly of white pine and chestnut which gave to the type the name of "pine and chestnut land," which still characterizes it. Most of these original forests were removed long ago and wooded areas now bear a second growth of chestnut and various species of oak. It is believed that a reforestation of the rougher, less easily tilled portions to the original native species of trees would not only be the best possible use for these areas, but would also prove profitable over more or less of the whole area as a long-term investment. Canada and Kentucky bluegrass are found by the roadside on this soil, but the Canada variety predominates, the other disappearing where the soil is in poor condition.

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The Volusia loam in Livingston County is a good indication of what the type might be wherever it occurs. The condition of agriculture prevailing upon it is much better generally than in some other sections. The crops grown are generally well adapted to the soil, but not a little improvement could be made in the methods of cultivation and in a fuller use of the land. The Volusia loam is a potato soil and the section of the county in which it occurs adjoins the potato section of both Allegany and Steuben counties, where the methods employed in growing them are better than in other sections where the suitability of the type for potato production has not yet been realized. Late Irish potatoes from extensive fields of this soil type average from 100 to 150 bushels per acre, while yields of 200 to 250 bushels per acre are not uncommon. Much more corn is grown than on the Volusia silt loam, though it is not extensively planted. It does much better than on the silt loam, yielding an average of 50 to 100 bushels of ears per acre with maximum yields of 100 to 150 bushels per acre. Barley will yield about 30 bushels per acre, though not extensively grown. Oats are particularly suited to this soil, and ordinarily yield from 35 to 40 bushels per acre, though much larger yields are possible. From 60 to 75 bushels per acre have been obtained. Buckwheat is also particularly adapted to this soil, and usually does well, giving an average yield of 20 to 25 bushels, with a possible 30 to 35 bushels per acre. Hay is an important product, the sod being principally of timothy and alsike clover, with some redtop (*Agrostis vulgaris*) and red clover. Yields vary from 1 ton or less to about 2 tons per acre.

Dairy farming is carried on to some extent on the Volusia loam and is generally successful, and it could and should be more extensively developed. The number of live stock should be increased, thus decreasing the sale of hay and increasing the quantity of natural fertilizer to be returned to the soil.

An ideal system of farm industry adapted to the Volusia loam would be dairy farming with potatoes as the main money crop. Other forms of animal husbandry, as sheep raising, stock grazing and feeding, and the production of pork for market could well be introduced in any system of farming upon this soil.

The agricultural conditions prevailing where this type of soil is found are fair and much better than in some other sections of the State where the same soil occurs, though as a rule they are not improving but, on the contrary, are probably slowly becoming worse. While the farm buildings are better than on the Volusia silt loam, they are hardly comparable to those found in the northern part of the county on other soils.

The price of farm land classed as Volusia loam varies from $40 to $65 an acre, depending upon location with reference to shipping

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point, condition of farm buildings and improvements, and upon previous management of the soil.

The following table gives the results of mechanical analyses of a fine-earth sample of both soil and subsoil of the Volusia loam:

Mechanical analyses of Volusia loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19451	Soil	1.1	2.7	1.7	7.1	14.1	55.3	18.0
19452	Subsoil	1.3	2.8	2.4	7.5	8.6	51.9	25.8

VOLUSIA SILT LOAM.

The surface soil of the Volusia silt loam to a depth of about 8 inches consists of a gray to pale-yellow silt loam. Where this typical material is found the soil has a dull, lifeless look, a poor physical condition, poor moisture-moving properties, and a low crop-producing power, and consequently low-grade, extensive systems of agriculture. Areas of Volusia silt loam in better condition, where more intensive and better systems of farming are practiced, have either a brownish or darker color, better physical, mechanical, and moisture conditions, and consequently higher crop-producing possibilities. The quantity of stone present is often large, though sometimes such material is almost entirely lacking. It consists for the most part of flat, angular fragments of the underlying country rock, either argillaceous or fine arenaceous shales, with sometimes an admixture of rounded, foreign glacial stones varying from small pebbles up to bowlders of considerable size. Where the arenaceous shales are found, the soil contains a higher percentage of the finer grades of sand and cultivation is attended with better results. This is also true of those areas where the rock fragments are more numerous. On the other hand, where the stone content is small or the fragments composed of the more argillaceous (clayey) shales the structure is close, soil moisture movements poor, and the soil material more compact, and it is more difficult to put the soil in good tilth. In areas of this character the soil is more likely to puddle or run together and must be handled under favorable moisture conditions and with much skill in order to secure the most beneficial results.

The subsoil of the Volusia silt loam to a depth of 3 feet is a light-yellow to gray, sometimes mottled, compact, silty loam. Like the surface soil, it carries varying percentages of arenaceous and argillaceous shale fragments, though foreign glacial rock material is much less in evidence.

As a whole, the depth of this soil material is 3 feet or more to the underlying bed rock, though in many places the subsoil rests directly

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upon the country rock within the 3-foot section. The compact character of the subsoil prevents aeration and oxidation, and these agencies have acted but little in their work of transforming raw soil material into forms for the support of plant life. This probably accounts, at least, in a measure, for the low crop-producing power of the type.

Successful cultivation and handling of this type of soil requires a thorough understanding of the principles of soil management and their intelligent application, but when these requirements are met the soil is utilized with not great difficulty and responds with larger yields.

The Volusia silt loam occurs in Livingston County only in the southern part, where it occupies broad areas, associated with the loam and gravelly loam types of the same series. The largest areas are found in Ossian, Sparta, and Springwater townships. It is also found in Conesus, West Sparta, Nunda, Portage, and Mount Morris townships, with one small area in Groveland Township.

The Volusia silt loam occupies the highest elevations within the county, almost its entire area lying between 1,200 feet and 2,260 feet above sea level. This location and the wide range in elevation give a surface configuration of rolling, flat-topped hills, with many steep slopes. The region as a whole has a rather rugged topography, though many of the plateaulike hilltops are nearly level and give no hint of the true physiographic relations of the type to the other soils of the county. It might be inferred from the hilly character of the soil that it had excellent natural drainage, but such is not the case. While the region is well watered and there are many springs and small streams, the natural drainage of the cultivable areas is deficient and crops suffer materially from excesses of moisture. This is particularly true of the more level fields situated on the high, flat hilltops. Many areas of this character are to be found in the uncleared portions, which are swampy, the water remaining on the surface at all times except during periods of extreme drought. In these more poorly drained places there is often a considerable accumulation of partially decayed organic matter, giving the surface soil a much darker color than is prevalent in cleared and cultivated areas. Besides these areas of deficient drainage in the more level parts of the type, many poorly drained areas also occur on the hillsides, not so much from the accumulation of surface water as from seepage from higher levels, the water flowing out through fractures in the underlying shale rock.

The compact and dense structure of the subsoil, locally called "hardpan," prevents free movement of the ground waters in any direction, thus making the surface run-off the only means of removing excess water, and this means is seldom sufficient to reduce the amount in the soil to an optimum quantity for plant growth. On the other

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hand, during droughts the same "hardpan" prevents to a considerable degree the rise of soil moisture from the deeper subsoil to the root zone, and as much injury then results from the lack of water as in the former case from the excess of moisture. Again, the texture and structure of both soil and subsoil is such that water is held within it much as water is held by a sponge.

All these factors combined make of the Volusia silt loam a soil badly in need of underdrainage, and no one thing would improve the type as much as this. If underdrained well, the mechanical condition and structure would be improved, better oxidation and aeration would result, better effects from the cultural operations would be obtained, better results from the use of fertilizing material, and better and larger crops produced, and, further, the agricultural and commercial value of the soil type would be greatly enhanced. But one thing stands in the way of the inauguration of this greatly to be desired improvement, and this is more apparent than real, the present low price, in many cases at least, being less than would be the cost of such improvement.

The Volusia silt loam owes its origin to the glaciation of the underlying country rock. In places this till mantle—ground moraine—is quite thick and in other places it is very thin. Nearly all of the soil-forming material is derived from the local geological formations, and often residual disintegration of these rock formations has contributed to the formation of the type, particularly in the case of the subsoil. It is likely that in many places the till was formerly much thicker than at present, and that it has been greatly modified and largely removed by postglacial erosion.

A considerable portion of this soil type is undoubtedly in an acid condition. Formerly excellent crops of red clover were grown without difficulty or much care, but since the development of the present chemical and mechanical condition of the soil it is impossible to grow this legume with ordinary methods of soil management and fertilization. On the contrary, redtop thrives, as do other varieties of plants which are resistant to acid conditions. This unfavorable chemical condition of the soil can be overcome and its injurious effects nullified by the use of lime. The quantity necessary will, of course, vary with the condition of individual fields, but as a general rule from 500 to 3,000 pounds per acre should be used. Just one word of caution in the use of lime is necessary. It should never be used directly before a crop of potatoes. Probably the best place in a rotation to use it is with the cover crop grown when the field is seeded for mowing. The application of either the oxide or hydrated forms should be made at least two weeks before any seeding or planting is done, or a goodly amount of rain should intervene between its application and the seeding or planting operations.

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Originally the Volusia silt loam areas were covered with a forest growth of white pine, chestnut, beech, sugar maple, and some hickory. There is now practically none of the original forest standing, though a considerable percentage is occupied by second-growth timber of the hardwood species. Wooded areas are found in most of the steeper, rougher portions of the type, and in such places some hemlock is also found.

The Volusia silt loam is particularly adapted to the production of late Irish potatoes, oats, buckwheat, and timothy. The chief money crop in the rotation on farms of this soil type should be the Irish potato. The quality is unsurpassed and yields are comparatively larger than those of other crops. The average yield secured per acre ranges from 100 to 150 bushels, though it is not impossible to secure, and many farmers are securing with judicious fertilization and improved cultural methods, 200 bushels per acre, or more. The importance of this type of soil for potato production can scarcely be overestimated. Similar soils and soil conditions make an adjoining county, Steuben, the third potato-producing county in the United States.

Oats are considerably grown and yields of from 30 to 50 bushels per acre obtained. Buckwheat is not grown to as great an extent as in some other counties having the same soil, though where grown it yields from 13 to 30 bushels per acre. Corn is not much grown and can not be recommended, except as a soiling crop and for ensilage or other forage. The high elevation precludes the growing of corn as a grain crop, unless some particularly early variety is planted. The grass crops are important, though the yields are rather low. Timothy and redtop are the principal grasses, while alsike clover is the principal legume. Mowing land usually cuts from somewhat less than a ton up to 1½ tons per acre. Red clover formerly was an important hay crop, but with the systems of farming and soil management followed the soil has passed into a condition which makes it extremely difficult longer to grow this legume, and as a result of the same conditions redtop has become one of the principal grasses. Likewise, alsike clover has become the leading legume, it being better able to withstand those conditions of the soil which are unfavorable to red clover. Canada bluegrass is not found native in either the mowing or pasture sods. Kentucky bluegrass is prevalent to some extent in areas where the better conditions obtain, though rare where the conditions are poorer.

The general agricultural conditions of the Volusia silt loam are not as good as the character of the soil warrants. The systems of farming, of soil management, and of agricultural methods are extensive and of low grade. Small numbers of live stock are kept and much hay is sold. In the way of improvement the following suggestions may be

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made: Some form of animal husbandry is essential to the best and permanent success of farming on this soil. In this connection, dairying, grazing, and sheep raising are logical systems of farming to be followed. By these systems all of the forage can be fed on the farm and the soil will receive all the waste in the form of stable manure, thus furnishing humus, which is so essential to crop production. In connection with this form of farming, soiling crops, such as Canada field peas, rye, buckwheat, etc., for feeding dairy cattle and the same or other crops for plowing under as green manures, should be grown. The point to be made is that the soil is deficient in organic matter and every means possible must be put into practice to restore this important soil factor. Deeper plowing, extending the depth gradually, and much better cultivation must be practiced in order to secure adequate results from any system of farming.

The influence of the individual soil type upon the price of lands is vividly shown in the Volusia silt loam of this survey. Farms of this type of soil are for sale and buyers scarce, at prices ranging from $8 to $30 an acre, according to improvements, condition of the soil, and location. The lowest-priced farms are in poor condition, the buildings unoccupied, fields abandoned and growing up to golden rod, briers, and weeds, and many of them not now profitably used for agriculture. They constitute the so-called "abandoned farms" of the State.

The following table gives the results of mechanical analyses of fine-earth samples of soil and subsoil of the Volusia silt loam:

Mechanical analyses of Volusia silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19447	Soil	1.4	2.9	1.7	4.2	5.2	61.3	23.0
19448	Subsoil	1.0	3.3	1.7	4.4	10.1	54.4	24.6

GENESEE SHALE LOAM.

The Genesee shale loam is closely allied with the silt loam of the same series and except for the presence of the shale it is very nearly identical.

The surface soil to a depth of about 7 or 8 inches is a brown to dark-brown silt loam, containing a great many small, thin, and flat shale fragments, a considerable portion of which are black in color. The subsoil is a grayish to light-brown and drab silt loam, the brown colors appearing in the lower depths. This is also filled with fine shale fragments. These shale fragments are all small, angular, and brittle, and can be easily broken. For the most part they are never larger or thicker than a silver dollar, the greater portion being much smaller and about the size and thickness of a penny.

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This soil has a rather open structure owing to the shale content, even though its texture is fine and close. While a good tilth is not very difficult to obtain, careful and skillful soil management should be practiced to maintain the soil in good condition.

The Genesee shale loam is not of wide occurrence in comparison with its associate type of the same series, the silt loam. It is found most extensively and typically developed in eastern Mount Morris Township, just to the southeast of the village of Mount Morris. There are several other small, scattered areas in the county where conditions have been favorable for the formation of the type.

The Genesee shale loam occupies a level to undulating topography slightly higher than the other members of the series, and consequently has very fair drainage, though underdrainage would likely prove of benefit. It owes its origin to the combination of overflow and stream influences. Small streams cutting down and through the shale rock as they flow from the uplands toward the river and valleys have brought down the small shale fragments from the narrow V-shaped gorges and upon reaching the lower country have mingled them with the flood-water sediments in delta forms. There are layers of almost straight fine shale gravel and layers of silt without any shale and sometimes small deposits of sands. The beds of the creeks which have brought down the shale gravel are completely filled with the small shale fragments after they reach the level lowlands.

The Genesee shale loam is particularly adapted to the production of hay, oats, and corn. Peas and string beans for the canning factories are grown in the vicinity of Mount Morris and good yields obtained. The string beans give heavy yields and are much better suited to the soil type than are those grown for the dry beans. Hay yields on an average 1½ to 2 tons and corn from 80 to 100 bushels per acre. Some sweet corn for canning and for drying is grown and heavy yields are secured, besides a large quantity of coarse fodder for feeding purposes. Some of the type is in pasture and generally has a good sod.

The Genesee shale loam is in a fairly good state of cultivation and the agricultural conditions existing upon it will average well with those prevailing throughout the county. No farm homes are located on the type.

In the following table are given the results of mechanical analyses of fine-earth samples of both soil and subsoil of the type:

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Mechanical analyses of Genesee shale loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19429	Soil	1.8	3.6	1.6	3.7	3.7	54.9	30.7
19430	Subsoil	7.0	11.3	3.5	6.4	4.2	40.9	26.8

Sample No. 19429 shows 25.1 per cent of fine gravel too large to be included in the fine gravel of the table, and sample 19430, 52.7 per cent.

GENESEE FINE SANDY LOAM.

The soil of the Genesee fine sandy loam, about 8 inches in depth, is a yellowish-brown to brown fine sandy loam. When dry it is very much lighter in color, being gray to almost white. The subsoil from 8 to 36 inches is a light yellowish fine sandy loam. In many places beds of stratified fine gravel and sand of various grades are found. These materials often appear at the surface and influence the soil as well as the subsoil, though as a rule there is more variation in the lower depths of the section and below.

This type of soil is easily cultivated and can be worked to advantage under a wider range of moisture conditions than can any of the other types of the same series. A good tilth and seed bed can be secured without any great amount of work or difficulty.

The largest and most important area of the Genesee fine sandy loam is located along the lower course of the Keshequa Creek after it reaches the Great Valley. There is also a considerable area in the aggregate along the upper course of the same stream from Tuscarora to Nunda and above, as well as in the bends of the Genesee River from the High Banks at Mount Morris upstream. These areas along the river have a more gray and mottled subsoil than do those along the Keshequa Creek. There are also some other small areas scattered throughout the county.

The topographic features of the type, though not level, are nearly so. In the Great Valley this soil forms a sort of natural levee on both sides of Keshequa Creek, while along the upper course of the same creek and along the river it occupies flat terraces as first and second bottoms. Small areas on the shores of Conesus Lake are low deltas built up by small streams flowing in from the higher lying soil formations.

The building up of the levee along Keshequa Creek has cut off the outlet of a small stream just below Sonyea, so that it now has no outlet except when there is a large enough volume of water to flow over the levee, thus developing a swamp area of considerable size which receives the waters of several small streams flowing in from the hillside above.

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The drainage of the type is fairly good, except where occupying first bottoms, which are subject to overflow during flood times. The favorable texture and structure of both soil and subsoil allows free and easy movement of water and soil moisture, and the physiographic position is favorable for a generous supply even during dry seasons.

The type is quite generally cleared and cultivated. It is an excellent corn soil, and yields of from 60 to 80 bushels per acre are ordinarily obtained. Beans do well and yield from 12 to 20 bushels per acre. Oats yield from 30 to 60 bushels, and hay, when in good sod, from 1½ to 2½ tons per acre. Potatoes do fairly well, but their production, except for home use, is not recommended.

The general agricultural conditions prevailing on the Genesee fine sandy loam are very good, though but few farm houses are located on it. It does not occur in extensive areas and never along the public highway, but is always held with other soil types making up the farms. No definite price for the type can be given, though it would likely sell alone for a price somewhat smaller than the silt loam and higher than the clay loam, being more easily cultivated and adapted to a wider range of crops than the clay loam type.

The following table shows the percentages of the various sized soil particles obtained from the mechanical analyses of a fine-earth sample of both soil and subsoil of the type:

Mechanical analyses of Genesee fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19431	Soil	0.1	0.7	1.7	22.4	29.4	39.8	5.9
19432	Subsoil	.4	3.1	5.9	24.0	30.5	31.0	5.2

GENESEE LOAM.

The soil of the Genesee loam is a dark-brown to gray silty loam from 8 to 10 inches in depth overlying a subsoil of gray to mottled material similar in texture, except that the lack of organic matter makes it appear considerably heavier.

This soil occurs only to a limited extent, being found as narrow stream bottoms in various parts of the county. It occupies low flood plains, but is generally fairly well drained, as the small streams all have rather rapid currents and their waters seldom remain out of banks for any length of time. The Genesee loam is the alluvial wash of these streams and has been deposited from the load of detritus in time of high water.

The type is mostly in permanent pasture, but when cultivated produces good crops of corn, hay, etc.

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GENESEE SILT LOAM.

The Genesee silt loam is one of the most important soil formations of the county. The soil consists of a gray to dark colored silt loam to a depth of about 10 inches, underlain to a depth of 36 inches by a mottled gray, olive, and brown compact silt loam. Where the elevation is slightly higher the color is more brown in all parts of the section and the texture more friable, the soil particles being of coarse rather than fine silt. There is commonly much organic matter present in the soil, giving it its dark color. Both soil and subsoil are entirely free from stones and gravel.

This type of soil is the most uniform in all characteristics of any found in the county. It is difficult to find two sections or borings whose descriptions would differ materially.

The Genesee silt loam is easily tilled, the soil being soft, mellow, and friable. It is easily worked to a good tilth for the seed bed, and this tilth can be maintained by later cultivation without difficulty.

The Genesee silt loam is extensively developed in the Great Valley, which extends from Dansville to the northern boundary of the county. In fact, it is by far the most extensive soil type occurring on this valley floor. The largest area extends north from Mount Morris to the vicinity of Avon on both sides of the river, unbroken by other soil areas, and southeast from Mount Morris to Dansville, along the Canasaraga Creek, but is here broken by small areas of the shale loam, clay loam, and fine sandy loam of the same series, and some areas of Swamp and Muck. This main body of the type is separated east of Fowlerville, where the river has no present flood plain, from another large area. A number of much smaller areas are found in other parts of the county. The topographic features of the Genesee silt loam show great uniformity and regularity, due to its physiographic position and consequent method of formation. Its elevation varies only from a little under 550 feet up to slightly above 600 feet above sea level, and by far the greater portion of the largest area does not vary more than 10 feet on either side of 565 feet above sea level, except along the edges of the valley floor and the upper end of the area in the vicinity of Dansville.

The drainage features of the type present a difficult problem. The whole surface lies so level that surface run-off is almost entirely lacking, and no outlet can be secured for underdrains, which would be open throughout the year, as the whole type is subject to inundation. The drainage conditions can be best understood by considering the origin of the soil-forming material and the processes of formation involved. The valley, whose floor is now occupied by this soil formation, was formerly a lake, not unlike the finger lakes of the central part of the State to the east. While this lake existed much fine material was brought down by the inflowing waters and deposited.

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While this stage in the process of the formation of the type was taking place, much filling undoubtedly occurred, and later, the glacial dam to the northward being removed, the lake waters were drained off, and then began the cutting of the High Banks of the Genesee River at Mount Morris, and further filling was accomplished by the overflow waters of the river. This process has continued ever since, and the end of it has not yet been reached. This whole valley floor is now often covered by the overflow of the river, and each high water carries with it and deposits its load of fine particles, thus silting up the whole surface and making new soil. It may not be flooded at all for three or four years, and then it may be completely inundated at times for three or four years in succession, the water often standing several feet deep for a few days or a week and longer during each overflow.

The "flats" were originally prairie land, though some oaks of immense size grew along the river banks and a few were scattered about on the prairie itself. This prairie, which we now call Genesee silt loam, was covered with a rank, luxuriant growth of wild grass, which attained a height of 8 to 10 feet, completely hiding a man on horseback when only a few rods away. The main flora of permanent sod ground is now Kentucky bluegrass, timothy, and white clover.

The Genesee silt loam is peculiarly adapted to the purposes for which it is used. The chief crops near a canning factory are sweet corn, peas, and string beans, large yields of each being secured. This type of farm industry is well and most extensively developed near Mount Morris and Geneseo. Asparagus beds in this vicinity promise success, as well as the growing of tomatoes. These crops are being extended each year. This soil type was formerly the great corn land of the Indians, and a considerable acreage is still grown for ensilage, which always yields a heavy tonnage. A considerable acreage is in mowing land and gives an average yield of 1½ tons of hay per acre. A large portion of the type is utilized for grazing purposes and is highly esteemed for the raising of cattle, but not for finishing them. Usually from 2¼ to 4 acres are allowed to each steer in the pasture and a gain of 250 to 400 pounds per steer is made during the season. This soil was formerly esteemed as an apple soil and orchards were profitable for a short time. As the trees make an enormous and rapid growth they are consequently weak and short lived, and for this reason and on account of overflow orcharding on this soil type is not advisable.

Over the most of the area of the Genesee silt loam all of the crops mentioned are subject to serious damage and even complete destruction by the overflow waters of the river. As a rule, however, the crops are safe from damage in this manner about three seasons in every five.

In spite of its liability to overflow the Genesee silt loam is highly esteemed and intelligently and successfully farmed. But few farm

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houses are situated on it, although the agricultural conditions are much better than those existing on some of the upland soil types, and the loss from overflow is less than from poor drainage on some of the upland soils.

Fields of Genesee silt loam for grazing purposes rent at $2.50 an acre for the season, and when utilized in growing truck crops for canning purposes they bring $7 an acre. The price of this land is high, though not higher than its intrinsic value warrants. Very little of the type is for sale. It is held at from $80 to $125 an acre, and the tendency is toward still higher prices.

The following table gives the average results of mechanical analyses of representative samples of both soil and subsoil of the Genesee silt loam:

Mechanical analyses of Genesee silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19433, 19435	Soil	0.0	0.7	0.4	2.0	5.0	70.2	16.7
19434, 19436	Subsoil	.0	.2	.3	1.4	5.5	71.0	21.6

GENESEE CLAY LOAM.

The surface soil of the Genesee clay loam is almost if not quite identical with that of the Genesee silt loam. To 10 or 12 inches in depth it consists of a heavy, dark-colored silt loam, resting upon a subsoil of dense, plastic, silty clay of a bluish to drab color to a depth of about 30 inches. Below this depth there is a yellowish-brown clay of the same consistency and character.

Although the texture of this soil is not particularly heavy the structure is close and there is poor aeration, slow movement of ground waters, and little oxidation. These factors account for the bluish colors, the iron content being largely in the ferrous condition. Owing to these conditions it is very difficult to secure a good tilth when cultivated.

The Genesee clay loam occurs only in the Great Valley. It is found in considerable though not particularly large areas associated with the other members of the series, notably west and northwest of Avon, in Caledonia Township, and southeast of Mount Morris, in the township of Mount Morris.

It occupies a low, flat topographic position, slightly lower than its associate soils. In general it is found next to the highlands, behind the natural levee built up by the overflows of the river. On account of this unfavorable physiographic position it has naturally very poor drainage, is wet, and low places in it are filled with water, especially

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during wet seasons. The permanent water table is always maintained within the 3-foot section or immediately below, even during periods of drought. During the severe drought of the present season (1908) the water table in the clay pits at Nova and along the Delaware, Lackawanna and Western Railroad tracks, southeast of Mount Morris, remained at about 3 feet below the surface, and pumping was necessary in order to work the clay beds. Some of the areas mapped as Swamp would if reclaimed become Genesee clay.

Like its associate members of the series as they occur in Livingston County, the Genesee clay loam is of comparative recent alluvial origin, and even now is undergoing the processes of formation. Occupying as it does a position in the flood plain away from the stream, it receives those sediments of the overflow waters held in suspension longest, the finest of the soil particles, the fine silts and clay. These being smaller and lighter and more easily carried by flowing waters are not deposited from the swifter moving currents at and near the main stream where it overflows, but farther back, where the currents are slower and the waters are quieter. Each overflow contributes its share to the surface, and as most of these low places have no drainage outlets the waters received in their basins deposit the entire remnant of their load in the course of time.

At this point it might be of interest to state that along the tracks of the Delaware, Lackawanna and Western Railroad, southeast of Mount Morris and in the vicinity of Nova, the subsoil clay beds of the type are worked, the clay being shipped and used with a calcareous marl (see Warners loam) in the manufacture of Portland cement.

The native vegetation of the Genesee clay loam is wild swamp grasses, soft woods, elms, etc. In the lower, more swampy places there are reeds, rushes, and other aquatic plant life.

For agricultural use the type is best suited to permanent pasture and the production of hay, with alsike clover as the legume, the red varieties not being suited to it on account of its poor drainage conditions. A good seeding can be secured, but it soon runs out, the wild swamp grasses crowding out the tame varieties. A considerable portion of the type is in permanent pasture. Practically none of it is used for cultivated crops, and until better drainage is established these crops can not be expected to thrive.

Better drainage is greatly needed, but difficultly obtainable. Underdrainage with tile is impracticable on account of the close texture and structure, and there being no available outlet suitable. About the only feasible drainage plan is to remove as much of the excess water as possible by means of open ditches.

The following table gives the results of mechanical analyses of a typical sample of both soil and subsoil:

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Mechanical analyses of Genesee clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium. sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19437	Soil	0.2	2.9	1.1	3.7	1.8	52.3	38.0
19438	Subsoil	.2	.4	.3	1.4	1.0	47.5	49.1

CLYDE FINE SAND.

The Clyde fine sand is a dark-gray to black fine sand, about 10 inches in depth, overlying a subsoil of gray sticky sand of the same texture. An impervious deep subsoil is present at no great depth, though a 3-foot section does not reveal it.

Very little of this type of soil is found in Livingston County, all that mapped occurring in York Township, northwest and southwest of Greigsville. It occupies depressions and is wet and swampy, the dense, deep subsoil assisting to keep the surface wet. These areas of Clyde fine sand are due to fine sands being carried into the depressions, where swampy conditions have formed the organic matter content which gives the surface soil its dark color. This soil represents the conditions under which Muck soils are formed, but the process of soil formation has not proceeded far enough in this case to form a Muck soil.

None of the Clyde fine sand is under cultivation, as it is too poorly drained. However, it should, when drained, make an excellent soil for cabbage, sweet corn, celery, onions, and the root crops.

CLYDE LOAM.

The surface soil of the Clyde loam is a very dark brown to black friable loam about 8 inches in depth, the dark color being due to an accumulation of organic matter from the decay of native vegetation. The subsoil consists of a gray to dirty yellow sticky loam, usually streaked and mottled with brown iron stains to a depth of 3 feet or more. While the above describes the typical section, there are variations in both directions. The whole section may be gritty with fine sands or it may be quite heavy from the presence of a higher percentage of silt and clay.

When under cultivation the type works up to an excellent tilth, as there is a fine granular structure where efficient drainage has been established.

The largest area of the Clyde loam is found northeast of Geneseo. The type is most extensively developed in York, Geneseo, Groveland, Livonia, and Lima townships, with scattered areas in the other townships, except those in the southern portion. No very large areas occur, but numerous small patches varying in size from a few

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acres to several hundred acres are found throughout the northern part of the county. The type is almost always associated with the Dunkirk soils, and rarely with the other soil series represented in the county.

All areas of the Clyde loam occupy relatively low topographic positions. Surrounding soil areas are always higher and drain into or through the depressions where it occurs. The poor drainage accounts for the development of the type. The lack of good drainage has produced an admirable condition for a rank growth of water-loving plant life, which by its growth and decay has developed the dark color of the soil by contributing the organic matter content. In fact, some of the undrained, uncleared, and uncultivated areas are even now in a semiswampy condition.

The original forest growth consisted of elms and soft woods, some of which still remain standing. The other native vegetation was of reeds, rushes, and wild grasses.

The Clyde loam is an excellent soil for hay and large yields are secured, ranging from 1 or 1½ to 3 tons per acre. When drained it is well adapted to the production of corn, cabbage, onions, celery, and the heavier and later truck crops, also to crops for canning purposes. Much of the type is at present in excellent permanent pasture and in woodlots.

The drained fields command a good price, but the type as a whole is not held at a high figure on account of its wet nature.

NUNDA STONY LOAM.

The Nunda stony loam to a depth of 5 or 6 inches consists of a light-brown surface loam containing a considerable quantity of small rounded glacial stones. The subsoil is a brown to bluish or slate-colored heavy loam or clay loam, also filled with rounded stones. Much of this stone content is limestone. The blue coloration is due to the low state of oxidation, no considerable amount of weathering having taken place. This soil type occurs only in the southwestern corner of the county, near Oakland, and is of very small extent. It is formed from the weathering of the glacial till of the Portage moraine, and has been developed both naturally and artificially. Erosion accounts for it in part and the excavation for the old Genesee Canal between Oakland and Lewis has given rise to some areas of it.

This soil type is unimportant from an agricultural standpoint, but affords positive proof of the existence of an extensive moraine underneath the lacustrine deposits of the region and accounts for some of the water-deposited material to the southward along the upper Genesee Valley. This moraine formed the dam which held the water imponded for a long time after the ice front had receded farther north-

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ward. It also helps to explain the development of the topographic features of the upper Portage Falls of the Genesee River. On account of its small development no crop adaptations or suggestions in that connection are necessary.

HONEOYE STONY LOAM.

The Honeoye stony loam consists of a brown loam filled with fragments of limestone of various sizes and shapes. The surface soil, only a few inches in depth, rests directly upon a solid massive crystalline limestone or upon a broken mass of the same country rock. Oftentimes the bed limestone rock itself appears at the surface as low ledges and anticlinal ridges or as a level rock floor without any soil covering whatever. Much of the limestone contains nodules of siliceous material or chert, and in fact a considerable percentage of the stone content is this cherty material. There is usually a small amount of glacial material and rounded stones scattered over the surface, but the limestone content is always markedly predominent. Fences around fields within and near this soil type are built entirely from the limestone blocks removed from the surface.

This type of soil is found only along the northern edge of the county, in the townships of Lima, Avon, and Caledonia. The topographic features consist of low ridges and shallow depressions, the surface being more or less broken, though the changes in elevation are slight. The natural drainage is usually excellent and even excessive during times of drought.

The occurrence of the Honeoye stony loam is due to glacial action and to weathering influences in breaking up the upper strata of the Onondaga limestone of Devonian age without depositing any considerable amount of foreign glacial material. It is likely, however, that formerly much more glacial material was present than now, it having been removed by the action of water at the close of the Glacial period or subsequently.

The native timber growth consisted mostly of oak and hickory and some of this original growth still remains in some of the more rough, stony, and shallow fields.

Much of the type is in permanent pasture and is peculiarly adapted to the purpose. Wheat, corn, clover, etc., usually do well on the deeper soil areas though they are likely to suffer from drought. Alfalfa has been planted to some extent and should do especially well after the first few years, when the roots have had an opportunity to reach down deep enough through the crevices of the rock to secure an adequate moisture supply, but this crop, as well as the others mentioned, is likely to suffer from lack of water.

The character of the Honeoye stony loam is such that only moderate agricultural development is possible. There are but few farm

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houses located on areas of the type, it being held in conjunction with other and more arable soils. The selling price is not high because of the difficulties attending cultivation and the susceptibility of the soil to drought.

WARREN SHALE LOAM.

The surface soil of the Warren shale loam consists of a few inches of drab to brown and light colored silty and sandy loam more or less filled with flat, angular, large and small fragments of the underlying shale and sandstone rock. There are also usually, though not always, a few rounded glacial stones and gravel of foreign origin. The subsoil consists of practically the same character of material, but less weathered and consequently lighter colored, more compact and dense, and probably slightly heavier in texture. The colors of the subsoil are olive, yellow, and brown from the stains of iron salts. There is in the subsoil also a larger percentage of fragments of the country rock and a smaller percentage of foreign glacial rock material. At any depth varying from a few inches to several feet the shale or sandstone rock is found in place. Vertical and sloping ledges of this rock, varying from a few inches to several feet in height, occur throughout the type. These ledges are sometimes of hard material which withstands weathering to a marked degree and again of soft material lending itself readily to the action of wind, water, heat, cold, etc., and is constantly breaking down and contributing new soil material.

The extremely stony, shaly character of this soil type and its physiographic position make it very difficult to cultivate.

The Warren shale loam occurs only in the southern portion of the county on steep hillsides. A long, narrow area is found on the east side of Marrowback Hill, along the west shore of Hemlock Lake. This area is about 9 miles in length, extending from Springwater to the foot of the lake and nowhere more than about three-eighths of a mile in width. For the greater part of its length its slope is exceedingly steep, rising over 500 feet from the level of the lake in the three-eighths of a mile of its width. Other areas are also steep, narrow, and ribbonlike in outline.

Owing to its steep sloping topography the type has for the most part excellent surface drainage, though in many places springs occur, the water coming out from the bedding and joint planes of the rock, making local areas wet. These springs and the close structure and texture of the subsoil make the type less susceptible to drought than would naturally be expected from its position on the steep hillsides.

Three factors have entered into the formation of the Warren shale loam, two of which stand out most prominently. The whole type has been glaciated, but its physiographic location is such that but little foreign material was deposited or else subsequent erosion has

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removed the greater portion of it. Although there is some glacial material present, the larger part of both soil and subsoil is derived from the underlying rock formations—shales and sandstones of Devonian age. The two important factors in the derivation of the type are the residual decay of the rocks from weathering influences and the gravitational creep down the slope of the loosened pieces of rock. Thus the type is in part glacial, in part residual, and in part colluvial, the last two being the dominant characteristics.

In several areas in New York the Warren shale loam has been mapped as Rough stony land, but is given a type name in this survey on account of its importance in being adapted to special purposes.

The natural timber growth was of hardwoods with some white pine and hemlock. Much of the type is now in second growth forest, a considerable portion in permanent pasture, and a comparatively small portion as it occurs in Livingston County is under cultivation. In the vicinity of Dansville and near the foot of Hemlock Lake it is given over to the production of a fine quality of grapes. A number of different varieties are grown, among which are the Concord, Catawba, Delaware, Niagara, Worden, etc. The yield varies with the variety, the season, and the care and skill of the individual grower, but on the whole the industry is successful and can be safely extended. Most of the product now grown is made into wine, though the grapes are unexcelled in quality for table use.

The Warren shale loam is at least one of the grape soils of the Keuka and Seneca Lake grape districts, and there is no reason except for occasional frosts, which also prevail in the regions mentioned, why the industry can not be extended as successfully in Livingston County as in her sister counties to the east.

The value or selling price of the Warren shale loam depends upon its proximity to town, the commercial value of the standing timber where forested, and the state of cultivation and buildings where cleared. In the edge of the village of Dansville it is held at several hundred dollars an acre, but higher up the hill in the same vicinity it may be bought at from $10 to $25 an acre. It is likely that away from the village-lot influence and aside from the timber it could be purchased at not far from $10 an acre, and in many cases that price would include the second-growth timber.

TUSCARORA SANDY LOAM.

The soil of the Tuscarora sandy loam is a mellow sandy loam of light-brown to gray color about 8 inches in depth. The sand content is a sharp, medium to fine sand, there being no considerable amount of the coarser grades. The subsoil is a yellow to gray sandy loam, sometimes mottled with iron stains. Pockets of sandy and heavy material are found throughout the whole section. This character of

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material forms the subsoil only to a depth of about 30 inches, below which there is a deep, dense, impermeable silty clay, drab to mottled in color. The soil is friable and easy of cultivation, as there are no stones or gravel, though a few small pebbles are sometimes scattered through it.

The Tuscarora sandy loam is of little importance in the county, as there are only three comparatively small areas mapped, one in the southern edge of Mount Morris Township near Nunda Junction, one near Tuscarora, and another in the southern part of Livonia Township. All of these areas are level or nearly so, the first two having an elevation of about 820 feet, and the other about 1,300 feet above sea level. The drainage is poor and crops suffer from wet conditions. The heavy, deep subsoil prevents the free movement of ground waters downward sufficiently far enough to bring about ideal moisture conditions for crop growth, and the generally level surface hinders the prompt run-off of the surface waters. Thus the only means of natural drainage is by lateral seepage, which does not take place quickly enough to prevent injury to the growing crops from excesses of moisture. Underdrainage with tile, placing the tile at or just above the deep clay subsoil, would undoubtedly prove of great value and the increased crop yields would soon pay all of the costs of the improvement.

The Tuscarora sandy loam is the result of a period of shallow lake conditions succeeding one of deeper and quieter waters, the latter depositing the heavy deep subsoil and the former the surface covering of sandy materials.

The native vegetation consists of wild swamp grasses and weeds. The original forest growth was oak and hickory, some of which still remains standing.

Probably the best use to which this soil type can be put is the production of hay and pasture. In its use for growing hay it should be seeded with timothy and alsike clover rather than with the red clovers, for the former is much more shallow rooted and thrives better under wet conditions. The larger part of the type is in mowing land and pasture, though some poor crops of beans and corn are grown. Hay will yield from 1 ton to 2 tons per acre, and beans from nothing in a wet season up to 10 or 12 bushels per acre in a dry season.

In handling the Tuscarora sandy loam even where underdrained the fields should be so laid out and plowed in narrow "lands" that all "dead furrows" may extend at one or both ends to the boundary between this soil and lower land. In this way at least some of the surplus of surface water can be removed.

Owing to the poor natural drainage conditions of the type the price per acre is not high, and there is practically no demand for the soil.

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The following table gives the results of mechanical analyses of a typical sample of both soil and subsoil of the Tuscarora sandy loam:

Mechanical analyses of Tuscarora sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19439	Soil	0.5	5.6	10.4	30.0	10.1	34.3	8.9
19440	Subsoil	26	11.2	17.1	32.7	7.9	19.9	8.9

LIVINGSTON LOAM.

The surface soil of the Livingston loam is made up of almost identically the same material as that of the Dunkirk loam. It consists of from 10 to 12 inches or more of grayish-brown to brown loam containing enough sandy material to make it mellow and to insure a good tilth. In a typical section this surface soil is about 1 foot in depth and rests upon a subsoil of greatly different character and origin. The upper part of the subsoil is usually a gray, sandy loam, mottled with brown iron stains, the sand being medium to fine in texture. Immediately below this intermediate stratum of sandy material is found the true subsoil, an olive to bluish colored dense silty clay, sometimes mottled with yellow and brown iron stains, though the characteristic olive colors remain predominant. In some areas the surface soil is lighter colored and has the characteristics of the Volusia soils with which these areas are associated rather than those of the Dunkirk series, but the distinguishing features of the subsoil, which gives to the type its agricultural value, remain constant.

The loamy surface soil makes the preparation of an excellent seed bed possible and subsequent cultivation of benefit if the soil is properly managed.

A considerable area of the Livingston loam has been mapped in this county, the most of which lies in York, Leicester, and Mount Morris townships, in the western part of the county, in West Sparta in the south-central, and Conesus in the eastern part.

The topographic features consist of rather flat to gently rolling fields, with very poor natural drainage, as a rule. The dense, close texture and structure of the subsoil prevents free movement of the ground waters, and consequently the surface soil has an excess of water, especially during wet seasons, and is greatly lacking in moisture supply during periods of drought. The characteristic texture and structure make it impossible for the soil grains to take care of and hold as much film water as is necessary to withstand and tide over even ordinary dry times. Neither can the subsoil care for any amount of space or ground water after heavy rains, but holds the free water above

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it in the surface soil, causing serious damage to and often complete loss of the growing crops, not alone by the inimical effects of the water itself on plant growth, but by preventing needed and beneficial cultivation. Underdraining practically all of the Livingston loam would greatly enhance its agricultural value and increase the yields of the crops. Many fields have been tile drained, and resulted in immediate benefit in not only quantity but quality of crops grown, as well as making it possible to handle the soil more at the worker's will instead of waiting for favorable weather and moisture conditions, which oftentimes do not come for such a soil. In one instance this season (1908) an excellent field of corn was seen growing on this soil type, and directly across the highway on a field with exactly the same kind of soil the corn had been drowned out and killed and the field refitted and planted to beans, which crop was almost a complete failure, the yield being small and of poor quality. The explanation is that one field was underdrained and the other was not. The importance of this question of drainage in respect to the Livingston loam can not be too strongly stated.

The origin and process of formation of this soil is of interest because of the widely different character of the materials going to make up the two different parts, the surface soil and the subsoil, and the unlike processes each has passed through in becoming component parts of the same soil type. The surface covering is composed of reworked glacial till and but little of it has been contributed by the underlying country rock. The stone content varies to some extent, but in all areas except those associated with the Volusia soils it consists largely of rounded, glacial erratics. However, in those areas on the eastern side of the county there is a high percentage of flat shale rock of various sizes and shapes, though it is none the less glacial till and has been moved a greater or less distance. The true subsoil has been formed by the weathering and decay of the soft strata of the shale country rock in place. When undisturbed the structure of the rock is still preserved in its weathered clay product and there is no marked separation between the rock and the subsoil, the one grading into the other. This residual subsoil comes to the surface in many places, notably at the corner of the State Normal School grounds in Geneseo and in other places, but nowhere in large enough areas to be mapped as a separate soil type. This residual material is almost identical in character with the Allis clay.[a]

The natural forests on the Livingston loam were hardwoods, like oak, hickory, elm, etc. Many areas were also swamps in their virgin condition, and the sod was of wild swamp grasses. There are now a number of groves of fine second-growth hickory upon the type.

[a] See Soil Survey of Madison County, New York, pp. 38-39. Advance sheets—Field Operations of the Bureau of Soils, 1906.

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Probably in its undrained condition the type is best suited to the production of grass for both hay and pasture, but when drained excellent crops of corn, beans, oats, wheat, and much better crops of hay should be secured. The present yields of all of these crops do not represent the inherent capabilities of the soil, except those secured from underdrained representative fields. The yields vary considerably, from total failures in some seasons to fairly good in other and more favorable seasons. As a fair average one can reasonably expect from 12 to 15 bushels of wheat, 30 to 40 bushels of oats, 12 bushels of beans, 50 to 60 bushels of ear corn, and from 1 to 1½ tons of hay per acre. All of these yields could be greatly increased by underdrainage, for records of 35 bushels of wheat, 60 bushels of oats, 20 to 25 bushels of beans, 100 bushels of corn, and 2½ tons of hay per acre on well-drained fields and in favorable seasons are not uncommon. A few fields were observed which were producing no growth whatever except worthless weeds, the fields being at least temporarily abandoned on account of their wet, poorly drained condition.

The agricultural conditions existing on the Livingston loam are not all that could be desired or all that is reasonably possible. Barns and houses are as a rule unpainted and there is a general appearance of neglect.

The price of farms on the Livingston loam varies from $30 to $50 an acre, according to location, buildings, drainage, and other improvements.

The following table gives the average results of mechanical analyses of typical samples of both soil and subsoil of the Livingston loam:

Mechanical analyses of Livingston loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19441, 19443.....	Soil.....	1.7	5.4	3.7	12.3	16.9	44.9	17.7
19442, 19444.....	Subsoil.....	.8	2.9	2.1	5.8	8.7	39.6	39.9

WARNERS LOAM.

The Warners loam consists of a few inches of brown to black muck overlying white to gray marl. The suface covering of muck is not always present, and in such cases the marl subsoil comes to the surface. Thin layers of muck are often found in the whole section of the marl. The surface soil if plowed at ordinary depths is seldom deep enough to prevent the turning up of some of the marl subsoil.

This peculiar type of soil occurs only in the northwestern part of the county, in Caledonia Township. It is always found at comparatively low levels and is wet and swampy.

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The Warners loam has been formed by the accumulation of marl (carbonate of lime) in bodies of fresh water. While many shells, the inorganic remains of aquatic animal life, are to be found in this marl, the largest portion of it was doubtless formed by the secretion of calcium salts by chara and other aquatic plants from the water and their diffusion and chemical alteration to the carbonate or less soluble form. During the time of this accumulation of marl there must have been lake conditions with clear waters containing a considerable percentage of dissolved lime. When the layers of muck were formed the lake waters must have been drained off, leaving swampy conditions favorable to the luxuriant growth of sphagnum moss and other aquatic plant life, the decay of which has formed the organic muck. Many shell forms are found intact, but the greater part of the marl is an impalpable mass which is soft and unctuous and bears no trace of shell forms. Stumps and tree trunks are found buried at various depths, sometimes in an almost perfect state of preservation.

The native vegetation consists mostly of softwoods and water-loving grasses, etc.

The Warners loam is not utilized as an agricultural soil, though good crops of corn and hay should be secured if sufficient drainage were established. This, however, is extremely difficult, for the water table is always high. The chief value of the type has been and is in the economic value of the marl as carbonate of lime. Alongside of the Lehigh Valley Railroad tracks east of Caledonia there is a large plant which uses the marl in the manufacture of cement, and near the same place there is a plant where the marl is dried and sacked and then sold as agricultural lime. Aside from this the chief value of the Warners loam is in the timber which the forested portion bears. There is no demand for it for agricultural purposes.

MUCK.

The Muck soil mapped in Livingston County consists of a mass of more or less decomposed plant remains brown to deep black in color and of varying depth. In all areas, however, the surface covering of Muck is more than plow deep, in many places it is 15 to 20 feet and more, and in other places not more than 6 to 18 inches deep. The underlying material varies in character nearly if not quite as much as does the depth of the surface muck covering. Those areas occurring in Caledonia Township are usually underlain by a white to gray calcareous marl, and where the covering of muck is lacking entirely or so thin that ordinary plowing reaches the marl, another soil type, the Warners loam, has been mapped, as elsewhere described in this report. In other places the true subsoil, no matter how deep beneath the surface, is either a bluish-gray clay or a sand of the same coloring. The character of the subsoil does not seem to influence the crop

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adaptation or the agricultural value of the type, which depends entirely upon the depth and stage of decomposition of the organic material. Some areas are less decomposed than others and resemble Peat to some extent, other areas have a dark-colored silty surface soil with true Muck below, and again other areas consist of the decayed and decaying organic matter bearing a high percentage of mineral soil material. These phases or variations from the true Muck are of less value for the special purposes for which the type is utilized and are seldom drained, cleared, and cultivated. When drained, Muck is mellow and most easily tilled, a seed bed of any depth desired being readily prepared.

Muck soil is a typical example of what is sometimes termed a "raw soil," that is, a soil formed of one character or class of material (in this case organic), to the exclusion or almost so of all other material.

Muck occurs in almost every township of the county, but only in the townships of Livonia, Lima, and Avon is it fully developed agriculturally. The largest single area is found in the Great Valley in the Canaseraga Swamp in Sparta Township, but much of this area is in forest and undrained. All of these Muck areas lie in comparatively low places and are very poorly drained naturally. They are level or very nearly so, and many open ditches are necessary to drain them. The origin and mode of formation of this soil is only accounted for by its low, poorly drained natural condition.

When the ice retreated from the region at the close of the Glacial epoch many ponds and small lakes were left in the depressions. Many of these were shallow and swamp vegetation at once began to grow. Through the growth, death, and decay of these aquatic plants and water-loving trees there has been a steady accumulation of decayed and decaying organic matter over the sandy or heavy subsoil. These bodies of water were at some subsequent time drained or partially drained and the accumulation of organic matter continued through the growth and decay of other forms of water-loving vegetation. In this way the soil classed as Muck has originated.

Very remarkable chemical characteristics of this type of soil are the high nitrogen content of the Muck soil and the high carbonate of lime content of the marl subsoil.

The native vegetation of Muck in its undrained and uncleared state is much the same as during the early stages of its formation. Softwood trees, reeds, rushes, wild grasses, sphagnum moss, and other aquatic vegetation grow luxuriantly and contribute their quota each year to the formation of the soil.

Muck is a conspicuous example of a special-purpose soil and its highest value is in the production of special crops. It is best adapted to onions, celery, lettuce, spinach, carrots, etc. The muck beds of the northeastern corner of Livingston County are intensively cul-

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tivated to the three crops first named—onions, celery, and lettuce. The average yield of onions on the South Lima fields is about 500 bushels per acre, although as high as 1,400 bushels have been harvested from an acre. Much early celery is grown, thus securing higher prices as well as larger yields, the rows being set closer together than is possible with the later varieties. The average number of plants grown on an acre is from 18,000 to 20,000, nearly all of which produce first quality celery, there being but few culls. Of the lettuce, the head varieties are grown, and an ordinary yield is 500 baskets of 30 heads each per acre. Spinach yields about 8 tons per acre for each crop and two and three crops can be grown each season. Carrots are sometimes grown and yield 20 tons per acre. All of these crops are particularly successful, and the average gross returns from each varies from $200 to $300 per acre, except in the case of spinach, which brings about $200 per acre for each planting, or from $400 to $600 a season.

The early celery is sometimes set in a double row, so that only one set of boards for each two rows is used in blanching. All of the other crops are grown in the regular way by ordinary methods. Commercial fertilizers of high grades are heavily used. It is a rather remarkable fact that the best results are always obtained from those fertilizers rating high in nitrogen, regardless of the high nitrogen content of the soil itself. For spinach a half ton is used per acre for each crop; for celery, about 1 ton of 4–8–10 grade is used per acre, and for lettuce about half as much of the same grade for each crop. There are several methods of fertilizer practice. About one-half of the growers apply the total amount about one week before setting or planting, and the others apply half of the total amount before setting and the remaining half in two subsequent applications. Although the use of lime is often advocated on soils of this character, the growers have found its use actually harmful.

The agricultural conditions prevailing on the cultivated areas of Muck are especially good, and the most intensive form of agricultural industry is practiced. The Muck areas at South Lima have been cultivated for about twenty years. Some time prior to their drainage and cultivation these swamps were considered of no value, but at present $400 an acre is the price asked for the best portions, and some fields have already been sold at $350 an acre. Much of this land is rented from year to year, and the cash rent varies from $20 to $30 an acre for the season.

ROCK OUTCROP.

The Rock outcrop of Livingston County consists of the narrow ribbons of steep and vertical shale cliffs along the deep gorge of the Genesee River and the steep V-shaped gorges of some of the smaller

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streams. These cliffs and gorges vary from 20 and 30 feet to 500 or 600 feet in height and have no agricultural value.

SWAMP.

A portion of the Canaseraga Swamp and other small areas in the Great Valley, together with some material at the heads of both Conesus and Hemlock lakes and elsewhere in the county, have been mapped as Swamp.

The soil material of these areas is generally a dark-colored mucky loam overlying a heavy plastic clay, though some of the largest areas located west of Groveland Station are a muck or peat and almost a treeless marsh.

The vegetation of these Swamp areas consists of the water-loving grasses, reeds, and rushes, these forming almost the entire covering of the prairie marsh just mentioned. Some of the areas are forested to elm and softwood trees, as soft maple, black ash, etc.

These swamps have no present agricultural value, though if drained would make very productive soils for corn, hay, heavy vegetables, and canning crops, and on the portion having a mucky soil celery, onions, lettuce, etc., would do well.

ADAPTATION OF SOILS FOR ORCHARDING.

Livingston County has not only the climatic attributes for successful apple orcharding through a great part of its area, but also possesses a sufficient range of soils to meet the soil requirements or preferences of the three varieties of leading commercial prominence in the East at the present time—the Rhode Island Greening, the Northern Spy, and the Baldwin. Other varieties of secondary commercial importance are also grown to advantage, and the opportunities are good for a steady and sane extension of apple orcharding.

Previous investigations by the writer have shown that the Rhode Island Greening succeeds especially well upon a clay loam surface soil, underlain by similar material. The surface soil must be sufficiently loamy to be readily maintained in good tilth, but so long as this condition can be secured a high clay content is desirable. The subsoil may well be of the same texture, or even heavier, so long as it is not too stiff for ready root penetration of this strong-growing variety. These conditions are supplied almost to the letter in the Dunkirk stony clay, of which the surface soil analyzes 32.9 per cent clay. This type marks, however, the heaviest extreme of soils desirable for the Rhode Island and needs to be kept in mellow condition by the use of decayed organic matter in some form. The Dunkirk loam and Dunkirk gravelly loam are also adapted to this variety in their heavier phases, and of the upland soils the most clayey areas of the Volusia loam and Volusia gravelly loam are best suited to the Rhode Island Greening.

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For the Northern Spy, soils with a lesser clay content than those described for the Rhode Island are desirable. Medium loams underlain by subsoils of heavy loam or light clay loam have given the best results. On more clayey soils the color does not develop satisfactorily if the rainfall is up to the normal, and, besides, the skins tend to be greasy. The tendency of the Spy to upright growth seems to be accentuated by too clayey soils, if well enriched, and such soils tend to promote growth faster than the tree is able to mature well. Sandy soils, on the other hand, produce fruit of good color and appearance, but the texture of the flesh tends to be coarse and the apple is much less juicy and of inferior flavor.

The Dunkirk loam, the Dunkirk gravelly loam, the Volusia loam, and the Volusia gravelly loam are especially suitable for the Spy. The Dunkirk stony clay in its average condition is less desirable. Where such organic content is maintained in its lighter phases as to keep this soil type in good tilth, excellent Spies have been grown on fields artificially drained, but this represents special rather than normal conditions, and does not offer safe criteria for guidance where the type has not been tile-drained. As a whole, the conditions in Livingston County seem very promising for the production of more Spies, as this variety is of first quality and excellent appearance. Soils adapted to its growth, furthermore, are limited to a much more restricted climatic range than for such varieties as the Baldwin, and consequently competition is not to be feared either for this variety or the Rhode Island Greening.

The Baldwin apple grows moderately well over a somewhat wider range of soils than the Rhode Island and the Spy. Its ability to do this has been one of the factors that has led to the commercial preeminence of this variety in the State of New York, but it has in perhaps no lesser degree led to the planting of numerous orchards of it upon soils so ill suited to its production that the fruit does not occupy a position as high in the market as it is capable of doing. Several factors contribute to the poor color and poor quality of no inconsiderable percentage of this variety as it appears on the market, but if it is planted only on soils capable of producing it at its best, or even reasonably near that point, it will suffer far less from competition with more highly colored fruit from western districts than it now does. Baldwins of high color and good quality may be grown on a surface soil of productive fine sandy loam, sandy loam, or light mellow loam underlain by a subsoil of the same texture, though preferably as heavy as a loam. A subsoil not heavier than a loam is desirable, but a plastic clay loam may also well be used, especially if the surface soil is a sandy loam. Such soils occur in such extent that planting on unsuitable soils is unnecessary. The principal types in Livingston County best furnishing these conditions are the fine

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sandy loam, the gravelly loam, and the loam of the Dunkirk series; the gravelly sandy loam, the gravelly loam, and the loam of the Caneadea series; and the gravelly loam and the loam of the Volusia series. Of the last, the Volusia loam, the most sandy areas should be chosen. Such areas are not sandy loams, but have been derived in part from arenaceous rather than clayey shales, and hence sand, principally of the fine grades, takes the place of part of the silt, giving a much more porous and open character to the soil than obtains where the type is derived principally from the clayey shales. To this phase of the Volusia loam in Livingston County the Baldwin is well adapted, and upon it orcharding might well be extended so as to constitute one of the leading money crops.

The soils mentioned, as well as other selected areas of minor importance, are in varying degree adapted to varieties suitable for family use and also to some varieties of secondary commercial importance, but space is not sufficient in a report of this kind to describe their soil preferences.

DRAINAGE.

The greater part of Livingston county is occupied by types of soil which require artificial drainage to make possible their largest productiveness. Attention has been called to this fact in the description of the county and in the discussion of each type of soil, but it is desired to emphasize further this factor in soil improvement because of its fundamental bearing on all other means which may be used for the improvement of the soils. Thorough drainage must be the starting point in the upbuilding of soil fertility, and without it much money will be wasted in labor, fertilizers, and crops.

The areas needing drainage are of two kinds: (1) Those embracing the marshy and swampy lands, and (2) those comprised in the higher-lying soils which are very generally included in tilled fields.

A small proportion of the county is naturally absolutely swampy. Such land includes, in addition to that mapped as Swamp, which is most largely developed in the Canaseraga Creek valley, the numerous areas of Muck soil, the two types of Clyde soil, and the peculiar Warners loam, which occur more generally in the northern half of the county. These areas are wet not only because of their own retentive character, but more especially because they receive the drainage from adjacent land. The Canaseraga Swamp can only be reclaimed by straightening and deepening the outlet channel, particularly in the lower part of its course. This, with levees to prevent overflow and clear channels to conduct the water from the local uplands and perhaps a number of flood gates to permit the drainage of the low areas without permitting their inundation, would practically reclaim to tillage all of the swamp land in that section. The large crop value of this land when so reclaimed will warrant a large

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expenditure for that purpose, and it should be considered also as an insurance against overflow at unseasonable times of the adjacent and larger areas of productive soil which are now cropped at a considerable risk.

The areas of Muck and Clyde soils are generally incipient ponds or lakes. The first step in their reclamation must therefore be to improve the outlet. The practicability of this step must be determined by the expense necessary to obtain such outlet and the area of the land which will thereby be improved. The greater part of the land can be reclaimed at a large profit. After the outlet is established the wet land must be further drained by both open and tile ditches to gather and remove the water. These must be arranged primarily to intercept the surface and seepage flow, to which the wetness is generally due. This necessitates a careful examination of each individual area with reference to these points. Surface ditches will be best in the early stages, but as soon as the land is well settled the majority of these should be replaced by tile. This is especially true on the Clyde soils. These drains should be placed about 3 feet deep and no tile smaller than 3 inches in diameter should be used. They need not be regularly placed and may be from 100 to 300 feet apart.

The second group of soils in need of drainage may best be discussed by series. In general it is only the fine-textured members that require such treatment. The gravel and sand types of all series have ample drainage. The fact that the surface of a soil has a good slope is no warrant that the drainage is adequate. The character of many of the types of soil is such that this is impossible. Hillside land may be as much in need of drainage as flat land. Wherever such land is included in tilled fields it is poor economy to bestow labor and seed even though the price of the land be very small, because in many cases the low price is largely a result of its low productiveness caused by wetness and the many other attendant difficulties.

Of the Dunkirk soils the gravelly loam is slightly in need of drainage in a few small areas. The fine sandy loam is considerably in need of drainage in many places, the loam is very largely poorly drained, and the clay is acutely in need of better drainage. The heavy character of the deep subsoil of the loam prevents the downward movement of the water absorbed by the more porous upper soil, making the type cold and backward and often springy. Tile drainage in this and the sandy and gravelly loam produces most gratifying results. The clay is very compact and impervious and will respond less rapidly to drainage. Fall subsoiling would be helpful. In the end the improvement will be pronounced.

The Caneadea silt loam and clay both require drainage. In addition to reducing wetness it will lessen erosion or washing.

In spite of their elevation and slope, the Volusia loam and silt loam are often seriously in need of drainage, and its installation will be a

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profitable investment. The need is more general on the silt loam than on the loam, owing to the greater persistence of the "hardpan" subsoil. The rather porous character of soil permits the absorption of the water, which can only be removed by slow percolation a long way over the "hardpan" subsoil or by evaporation. Tile should be placed about 2½ feet deep and the ditch filled to the top of the "hardpan" with flat stone to facilitate the admission of water. In general, the lines of tile should extend up and down the slope. Lines 100 to 150 feet apart will work great improvement. At the high elevation at which these soils occur the warming of the soil and the consequent lengthening of the growing season is a very important factor to be considered.

The compact character of the subsoil of the Tuscarora sandy loam and the Livingston loam is directly responsible for their naturally poor drainage, and this practice is most emphatically at the basis of their improvement. The tile should be placed near the top of the hard subsoil, and in the latter case the admission of water is facilitated by the use of stone over the tile.

The position of the Genesee soils makes thorough drainage difficult because of the possibility of overflow. If the overflow can not be practicably controlled the land should be so treated as to facilitate the removal of the water after the subsidence of the flood. Surface ditches will be most generally used, but tile drains are also feasible over large areas.

The Warren shale loam, which is made wet by seepage from the joints of the bed rock, should have this intercepted in some practicable way. If the flow is nearly all from above, a single deep drain on the upper side along the face of the hill will be very effective.

The need of drainage by a soil is shown by the uneven color of the subsoil and by the presence of pale yellow, gray, and blue colors. Also by the dense impervious structure. Both of these will be changed with good drainage, and this portion of the soil section will become more congenial to plant roots and, therefore, more serviceable in supplying food and moisture for a larger growth.

In general, the sandy and silt soils may be drained at a depth of 2½ to 3½ feet and the tile from 100 to 300 feet apart. On clay soil the drains should be not over 2 feet deep and nearer together. Fifty feet will doubtless be the minimum interval under ordinary crop conditions and a greater interval will still produce much improvement. As improved methods of tillage, crop rotation, and fertilization are increasingly applied, the need for better drainage will be increasingly felt. The practice requires the exercise of much good judgment, but when so applied no other form of improvement gives better returns for the care and money bestowed.

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SOIL SURVEY OF MONTGOMERY COUNTY, NEW YORK.

By ORA LEE, Jr., assisted by CLARENCE LOUNSBURY, of the New York State College of Agriculture.

DESCRIPTION OF THE AREA.

Montgomery County is situated in the eastern part of the State of New York, in the heart of the Mohawk Valley. It is included within meridians 74° 5′ and 74° 46′ west of Greenwich, and parallels 42° 46′ and 43° 3′ north latitude. The county is bounded on the north by Fulton County, on the east by Saratoga and Schenectady counties, on

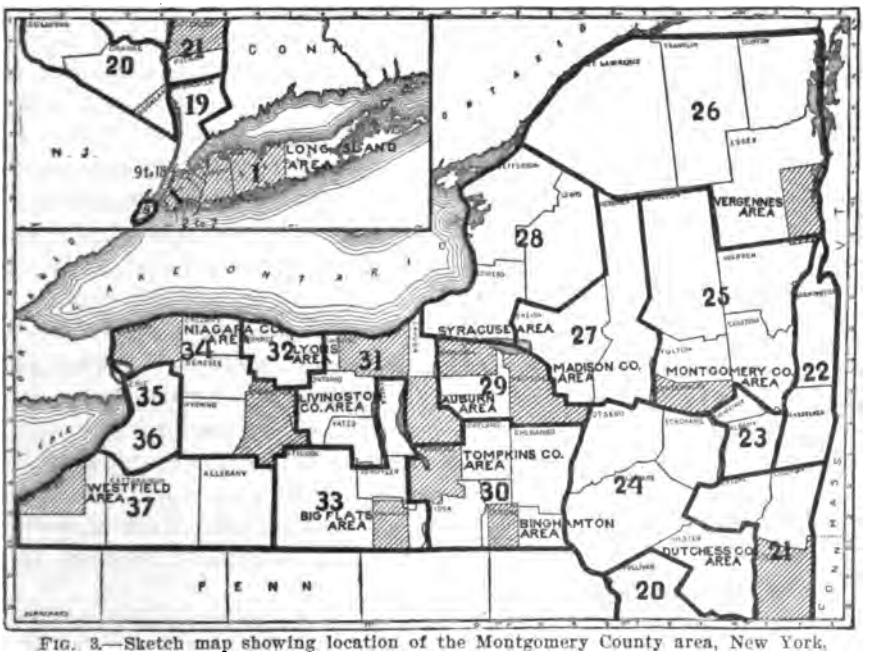

FIG. 3.—Sketch map showing location of the Montgomery County area, New York.

the south by Schenectady, Schoharie, and Otsego counties, and on the west by Herkimer County. It is somewhat irregular in outline, but is roughly rectangular in shape, being about twice as long as it is wide. The Mohawk River flows eastward in a more or less meandering course, dividing the county into two nearly equal parts. There are 259,200 acres, or 405 square miles in the county.

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Practically the whole county belongs to the Mohawk Valley province, the northern boundary being approximately the line between the valley proper and the foothills of the Adirondack Mountains, while the southern limit of the county is the somewhat arbitrary line drawn between the valley and the foothills of the Catskill Mountains.

The channel of the Mohawk River averages about a half mile in width, but only during the spring months is it filled with water. During the summer and fall the stream is confined to a narrow passage from 100 to 200 feet wide, and in places the water is only a foot or so deep. The altitude of the river at the point where it leaves the county is about 250 feet, and where it enters the county about 300 feet. Back from the river the hills on each side rise to elevations varying from 200 to 400 feet in a distance of less than 1 mile, where they merge gradually into the gentle, though somewhat irregular, slopes which extend toward the mountain foothills along the county boundaries on the north and on the south. There are a few places, however, where there are precipitous walls 300 to 400 feet high along the river. The average altitude along the northern county boundary is about 750 feet, and along the southern boundary about 1,000 feet. Oak Ridge, elevation 1,450 feet, in the southeastern corner of the county, is the highest point in the area, so that within the county there is a range in elevation of about 1,200 feet.

The topography is in general sharply undulating, but with many gently rolling areas having just enough slope for good surface drainage. In the southwestern and southeastern corners of the area, for example, the surface consists of irregular rounded hills, while in the south-central part the surface features consist of parallel ridges of remarkable uniformity. These ridges extend in an east and west direction and are from one-half to 2 miles long, 20 to 75 feet high, and from a few yards to one-half mile wide. The northwestern corner of the county consists of an irregular slope extending gradually from the river to the county boundary, while the northeastern corner is composed largely of broad, plateaulike areas.

The Mohawk River, which flows eastward into the Hudson, is the main drainage outlet of the county and eventually receives the waters of all the other streams.

The first settlers, and for a long time the only settlers, in this region were the Dutch and the Germans, and to the present day their descendants are found here in large numbers. A few Scotch and Irish came in before the Revolution. After the Revolution large numbers of New Englanders were attracted by the confiscated land of Tories, though many of them took up and cleared new lands. In recent years a few Poles and other Europeans have entered the region and are engaged in agriculture.

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In 1890 the population of Montgomery County was 45,699. The greatest increase has been in the towns along the river, where there are a number of manufacturing and industrial enterprises. The farming population, however, has made a healthy increase, except in the southern part of the county, in the vicinity of Charleston Township, where many abandoned farm buildings are seen, and field after field formerly cultivated now yields only a small cutting of hay or furnishes meager pasturage.

Amsterdam, with a population of 21,000 in 1900, is the only city in the county. Fort Hunter, Fonda, Fultonville, Canajoharie, Nelliston, Fort Plain, and St. Johnsville, with populations ranging from 500 to 2,000, are thriving towns situated along the river. Besides these there are many smaller towns along the river and smaller streams. Amsterdam is a thriving manufacturing city with carpet and knitting mills, broom factories, and a variety of other industries. Several of the smaller towns have knitting mills and factories. Milk stations and condenseries furnish employment to a good many people. Gloversville and Johnstown, just out of the county, furnish excellent local markets for all farm products. All produce not used in the county and near-by cities finds its way to New York and Hudson River cities by way of the New York Central and Hudson River Railroad, the West Shore Railroad, and the Erie Canal. Milk, the most important agricultural shipment, goes largely to New York, Albany, and Troy by rail. The railroads also carry a large quantity of hay, though a considerable part of this crop is shipped by canal.

CLIMATE.

There are no weather records available for any points within Montgomery County, but complete records have been kept at Albany and Cooperstown, not far distant, and from these the following tables have been compiled. The elevation of these two stations is such that Albany may be taken as representing the lower valley conditions and Cooperstown, which lies 1,200 feet above sea, as showing the conditions in the higher parts of the county.

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Normal monthly, seasonal, and annual temperature and precipitation at Albany.

Month.	Temperature.			Precipitation.			
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for driest year.	Total amount for wettest year.	Snow, average depth.
	°F.	°F.	°F.	Inches.	Inches.	Inches.	Inches.
December	28	66	−17	2.7	1.0	6.2	10.0
January	23	62	−24	2.6	4.0	4.4	12.8
February	24	63	−18	2.6	4.7	4.1	14.0
Winter	25	.....	.....	7.9	9.7	14.7	36.8
March	33	75	− 8	2.8	1.0	2.2	11.1
April	46	88	13	2.4	1.6	4.0	1.2
May	59	93	29	3.0	2.5	3.6	Trace.
Spring	46	.....	.....	8.2	5.1	9.8	12.3
June	68	99	40	3.7	3.6	4.5	0.0
July	73	100	48	3.9	2.2	5.5	0.0
August	71	98	42	4.0	3.3	3.8	0.0
Summer	71	.....	.....	11.6	9.1	13.8	0.0
September	64	96	33	3.2	1.5	3.2	0.0
October	51	90	23	3.1	1.8	3.4	Trace.
November	39	71	−10	2.9	0.7	4.4	4.7
Fall	51	.....	.....	9.2	4.0	11.0	4.7
Year	48	100	−24	36.9	27.9	49.3	53.8

The average date of last killing frost in the spring is April 24, and of the first in the fall October 18.

Normal monthly, seasonal, and annual temperature and precipitation at Cooperstown.

Month.	Temperature.			Precipitation.			
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for driest year.	Total amount for wettest year.	Snow, average depth.
	°F.	°F.	°F.	Inches.	Inches.	Inches.	Inches.
December	25	62	−15	2.8	3.3	4.3	13.1
January	20	62	−21	2.6	1.7	4.4	14.0
February	21	57	−23	2.5	0.8	2.9	18.7
Winter	22	.....	.....	7.9	5.8	11.6	45.8
March	28	70	−15	2.8	2.3	4.2	12.8
April	41	82	14	2.7	2.2	2.9	2.4
May	54	87	24	3.6	3.4	8.8	0.1
Spring	41	.....	.....	9.1	7.9	15.9	15.3
June	64	90	35	4.2	1.0	4.9	0.0
July	68	92	40	4.5	1.8	3.4	0.0
August	66	90	38	4.4	5.8	6.0	0.0
Summer	66	.....	.....	13.1	8.6	14.3	0.0
September	58	87	29	3.4	2.9	7.2	0.0
October	47	80	20	3.3	2.4	5.9	0.7
November	35	70	0	3.1	2.4	3.2	5.2
Fall	47	.....	.....	9.8	7.7	16.3	5.9
Year	44	92	−23	39.9	30.0	58.1	67.0

The average date of last killing frost in the spring is May 7, and of the first in the fall October 1.

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From these tables it is seen that the average annual rainfall ranges from 36.9 inches to 39.9 inches, the larger figure for the more elevated positions. Even in the driest year on record the rainfall was 27.9 inches at Albany and 30 inches at Cooperstown. As the distribution of precipitation through the seasons is relatively uniform, the region, so far as moisture supply is concerned, is favorable to agriculture.

As regards temperature there is a difference of 4° F. in the means for the two stations, Albany showing 48° F. and Cooperstown 44° F. There is but 1 degree difference in the absolute minimum temperature, —24° and —23° F., respectively, and 8° F. in the absolute maximum, 100° and 92° F., respectively.

Judging by these records, there is considerable local difference in the climate of Montgomery County, and observations on the farm practices tend to confirm this conclusion.

In general the summers, though warm, have few extremely hot days, and the nights are usually cool. The winters are in many years severe, though being accompanied by heavy snowfall (the mean for Albany is 53.8 inches and for Cooperstown 67 inches), fall-sown crops are well protected, and damage from freezing or heaving is minimized.

The first snows may come in October, though winter seldom sets in until the latter part of November. Sometimes the spring season does not open until the first of April, but as a rule the frost is out of the ground and well-drained land may be worked in the early part of March.

AGRICULTURE.

The Indians practiced agriculture in the Mohawk Valley before the arrival of the white man. Squaws cultivated corn, beans, squash, and pumpkins to a limited extent in the neighborhood of their villages along the river. The cultivated fields are said to have been located on the river flats, and there were also a few Indian apple orchards on the uplands.

As early as 1711 a few white men came to this region to locate, and the first permanent settlement was made at Stone Arabia in 1723. These people were Germans and were bent on establishing homes where they would be free from religious persecution. Each family took up a piece of land and began at once to clear it for the purpose of growing corn, wheat, potatoes, flax, and such other crops as were necessary for food and clothing. The land was mostly forested. In order to clear it the trees were felled, and a few of them utilized in building log houses and stockades. The others were rolled together in piles and burned. The agriculture was crude; crops were planted among the stumps for a few years until these decayed so that they could be more easily removed. Most of the

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work was done by hand. Grain was thrashed with a flail or by horses tramping over it. At first it was either ground at home with a wooden pestle or taken on horseback or by boats to the flour mills at Schenectady. A little later gristmills were built along the larger streams in the county. Each family attempted to produce just enough of everything for its own consumption. The women spun the yarn from the flax, wove the cloth, and made the clothing. The first settlers brought with them a few cattle, and thus began the dairy industry which at present holds such an important place in the agriculture of the county. Sheep were introduced almost as soon as cattle, and the wool was carded and spun and made into clothing. Sheep raising attained its greatest importance about 1860, since which time it has steadily declined. Horse breeding received some attention, and early writers refer to the many fine horses seen in the Mohawk Valley in pioneer days. There are now several large farms devoted to the breeding of fine stock.

Oats, corn, rye, buckwheat, and barley were all important crops in 1850. Wheat was grown to some extent and reached its maximum production about 1880, but the acreage has since decreased rapidly. Oats have always led in production and are still the most important grain crop, though the largest yield was in 1860. Corn has always held second place, and while at present it probably equals oats in acreage, so much is used as ensilage that the production of grain as returned by the census is not a true measure of its importance. Buckwheat still holds an important place on certain classes of soils, but barley and rye have ceased to be important crops. A few hops have been grown in the western part of the county from the earliest days, reaching their maximum production in 1900. For the last few years the low price has discouraged their production, and they have come to be considered such an unprofitable crop that the yards are being abandoned.

Prior to the civil war the only marketable dairy products were butter and cheese, which were made on the farm and the surplus sold in local markets or shipped in small quantities. About this time the improvement of transportation facilities and the advent of butter and cheese factories gave an impetus to the dairy industry. The greatest number of milch cows, over 26,000, is reported in the census of 1870, about which time milk was first sold extensively. The sale of milk in that year amounted to 5,000,000 gallons. Much of it at first went to butter and cheese factories, but as the demands from New York and other cities increased more and more of the milk was shipped and at present most of it is disposed of in that way. Of the 10,500,000 gallons produced in 1900 nearly 7,000,000 gallons were sold. The demand is increasing faster than the supply and competitive buyers are reaching out beyond ship-

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ping points by means of collecting wagons, so that farmers are saved the expense of delivering milk. In places distant from the railroad the milk is skimmed and only the cream sold. Cheese factories and condenseries consume a small proportion of the supply, while most of it goes to New York, Albany, and other cities by special milk trains. When most of the milk was used for making butter and cheese it was produced during the summer season and the cows were allowed to go dry in winter, but later the higher prices paid in winter warranted a change in management so as to prolong the milking throughout the year. This necessitated a change in the feeding system. Silos were built to store ensilage for winter use, more attention was paid to the production of hay and fodder, and the grain ration was increased. Cattle were more carefully housed and the recent restrictions of boards of health as to the sanitation of the stables have done much to improve the quality of the milk supply which goes into the large cities. Increased attention to the quality of milk has also necessitated more careful breeding. Holsteins prevail and many herds include registered stock. It is not unusual to include in the herds a few well-bred Jerseys to increase the butter-fat content of the milk.

The general type of farming in the county to-day is dairying, with the production of hay, grain, and special crops, such as market-garden produce, near some of the larger towns, a little fruit in the eastern part of the county, and a few hops in the extreme western part.

In 1900 more than one-third of the area in farms was in grass and grains cut for hay, giving an average yield of 1¼ tons per acre. Of this acreage 2,558 acres were in clover and over 81,000 acres in other tame grasses, mostly timothy. Next in acreage were oats, 26,640 acres yielding 829,000 bushels, a little over 30 bushels to the acre. Corn occupied 11,449 acres and yielded 373,500 bushels, less than 33 bushels to the acre. A little over 5,000 acres of buckwheat, largely on the Volusia silt loam and adjoining areas of the Mohawk silt loam, gave an average yield of 16 bushels. Wheat and rye were each credited with a little more than 1,000 acres and an average yield of 18 bushels. The acreage has declined since that time. The 620 acres of barley produced 14,200 bushels, or 23 bushels per acre. The production of potatoes was 199,738 bushels, grown on 2,483 acres—hardly enough to supply the home and local market demand. There were 1,425 acres in hop yards yielding less than 465 pounds to the acre. The value of orchard products was given as $48,834. As a rule the orchards are small and poorly cared for, and little attention is paid to packing the fruit.

The total area in farms in 1900 was 236,934 acres, of which 202,394 acres were improved. The average size of farms was 98.4 acres. The

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total value of farm lands was $5,941,600, an average of $25 an acre, and the total value of buildings, improvements, and machinery amounted to nearly the same figure. The capital in live stock was $1,608,651. The value of products not fed to live stock was $2,064,886. Deducting from this $358,780 expended for labor and $17,810 for fertilizers, leaves a net return of $1,688,296 upon a total investment of nearly $13,000,000 and the labor of farmers and their families. Reducing these figures to an individual basis shows a net return per farm of about $700 on an average investment of $5,400 and the farmer's labor.

The adaptation of soils to crops is well recognized by the farmers. The Mohawk series, especially the clay loam, is considered the best dairy soil because of its adaptation to corn and grass. The Palatine soils are even more highly esteemed, returning larger yields and bearing a higher valuation, but their limited area renders them a less important factor in the local agriculture. Both of these groups of soils are well suited to clover, especially the darker colored types, which are underlain by the black Utica and Hudson River shales. Corn is also grown extensively on the more loamy phases of the Dunkirk gravelly loam, and a larger proportion of the Genesee fine sandy loam than of any other type is devoted to this crop, with the possible exception of Palatine silt loam. Buckwheat is grown extensively on the Volusia silt loam, which is probably better adapted to it than to any other crop. A little is grown on the lighter phases of the Mohawk silt loam where it approaches the Volusia soil. Oats are grown on all types. The Genesee fine sandy loam returns good yields. The Volusia silt loam and the lighter textured Dunkirk types bear a large acreage. This grain is also grown extensively on all types of the Mohawk series, the silt loam perhaps being preferred over the other members. Grass occupies the largest acreage of any crop in the county and is grown on all soils. Dunkirk clay is esteemed for timothy hay for market, because of the bright color of the product. Onions, berries, sweet corn, and market-garden crops occupy a large proportion of the Dunkirk coarse sand. Hops are grown in the southwestern part of the county on Dunkirk gravelly loam, Mohawk clay loam, Mohawk silt loam, and Volusia silt loam, the average yield on these soils decreasing, but the quality of the product improving, in the order named.

Rotation of crops is often practiced more because of convenience in management than because of its beneficial effects upon the soils and the increase in crop yields. The usual practice is corn one or two years, oats one or two years, after which the land is seeded down to remain in meadow for several seasons, until the sod runs out and requires renewing. The system is often varied with other crops in place of corn or oats. On the river flats grass is seldom allowed to

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remain more than one season, as the Genesee fine sandy loam is in great demand for corn and oats. Notably on the Volusia silt loam, but to some extent on other types, mowing lands are allowed to stand for ten or fifteen years, until there is hardly enough grass to pay for cutting, and are then plowed one year for oats and reseeded.

Agricultural methods on the better soil types are well adapted to present conditions. The dairy industry creates a great demand for hay, corn, and grain, and rotations are planned to supply these crops. Labor-saving farm machinery, including manure spreaders, is used extensively. Deep plowing and thorough cultivation are usually practiced.

In the poorer parts of the county, however, there is a pronounced lack of intelligent management. More manure is allowed to waste in regions occupied by soils most in need of it than in those sections where the soils are naturally more productive. Plowing here is universally shallow, cultivation is neglected, and crop rotation receives little or no attention. It is also a significant fact that from the poor lands most in need of organic matter and careful conservation of farm resources the selling of a large proportion of the hay is a common practice.

The farm-labor problem is critical and one of the most difficult things which the farmers have to face. The increased demand of factories and shops for labor throughout the year has attracted many from the farms, where employment is usually furnished for only seven or eight months, leaving an enforced idleness for the remainder of the season. High wages are offered for a few weeks during harvest time, but it is difficult to get sufficient help at any price. As a result many farmers must depend upon the efforts of themselves and the members of their families. A few foreigners, chiefly Poles, are employed on farms at $24 to $30 a month for eight months and retained at a nominal figure during the winter season. Native labor is very scarce and demands higher wages.

Less than 60 per cent of the farms are operated by the owners. The usual tenant system is on a share basis. The owner furnishes, besides the land and permanent improvements, one-half of all seed and commercial fertilizers and a part or all of the dairy stock. The tenant provides horses, tools, and working equipment and one-half of the seed and fertilizers. The gross receipts are divided equally. The agreement is varied occasionally, but this outline forms the basis of practically all share systems. Cash rent is seldom paid.

The farm lands of Montgomery County have a wide range of valuation. The river flats occupied by Genesee fine sandy loam are often held at more than $100 an acre, and there are a few well-developed farms on the adjoining uplands closely approaching this valuation. In Charleston Township and vicinity and parts of Florida there are

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extensive areas of Volusia silt loam which can be purchased for $7 to $10 an acre.

In considering the agricultural conditions of Montgomery County with a view to their improvement, the region occupied by Volusia silt loam claims first attention. Its present value and productivity are far below normal, owing in a large measure to poor management and excessive waste of natural farm resources. Systems copied from other sections, but not well adapted to this soil, have resulted in poor success, which naturally led to neglect. A revised system of management is necessary in order to use all of the hay and roughage on the farms and return to the land a large part of the organic matter, of which it is greatly in need, but is now being deprived by the extensive sale of hay. Distance from shipping points minimizes its utility for dairying, but it is admirably adapted to the production of beef cattle and sheep. Deeper plowing is necessary. Instead of being left in sod for a long period of years the fields should be broken as often as possible and more thoroughly tilled. A systematic rotation of crops should be introduced. The maximum use of both stable and green manures can not be too strongly urged. This last suggestion also applies to nearly all parts of the county.

The problem of underdrainage is little understood and seldom considered seriously, though a matter of great importance on all soils in the county, except a limited area of loose sandy and gravelly loams. The removal of surplus water from depressions is all that is usually considered necessary, but there are many level areas and even hillsides where a thorough system of underdrainage is desirable, especially where there are heavy subsoils, as it not only provides for the removal of excess water but improves the structure of the soil mass and renders it capable of retaining a sufficient moisture supply in times of drought. Clovers and other legumes are well adapted to the Palatine soils and also to the darker members of the Mohawk series. These crops are not only excellent feeds, but are also of great value in building up the soil. Deep plowing, thorough tillage, and a systematic rotation of crops should have careful attention throughout the county, and the rotation should include clover or some other legume.

SOILS.

The soils of Montgomery County fall naturally into four groups—glacial soils, or those derived from glacial débris; glacial lake sediments, or the glacial débris reworked and deposited in ancient lakes now drained; residual soils, or those formed through the breaking down of rocks in place; and alluvial soils, or those resulting from stream sediments.

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During the Glacial period the whole region was covered by the ice sheet, the movement of which was from west to east through the Mohawk Valley. About four-fifths of the surface of Montgomery County and much of the region to the westward is immediately underlain by soft, thin-bedded, black, easily eroded shales of the Utica and Hudson River formations. When the ice sheet moved through the valley large quantities of these soft rocks were eroded, ground up, and mixed with the other glacial material, and when the ice sheet melted or passed away it left a mantle of variable thickness over practically the whole surface of the county.

The residual soil areas represent locations where there is no glacial material upon the surface and the underlying rocks have weathered so as to form the soil. In the northeastern part of the county, for example, there are several areas where the hard, gray, Lower Silurian limestones, coming close to the surface, have weathered into the residual soil type mapped as Nellis loam. Along the river bluffs and along the northern boundary of the county there are a few outcrops of Archean rocks, but these are so hard and resistant to the agencies of weathering that they have not formed soils. These outcrops give rise to small areas of Rough stony land.

The glacial mantle is in many places so thin that the underlying rocks enter largely into the soil formation, giving the soils some of the characteristics of both residual and glacial types of soils. There are large areas in the county for instance where the soft dark-colored shales of the Utica and Hudson River formations lie so close to the surface that fragments and finer material derived from them have been incorporated with the glacial material brought from a greater or less distance. These conditions have given rise to the dark-colored soils of the Palatine series. In the southern part of the county also there are areas where the light-colored shales and fine-grained sandstones, which here lie close to the surface, have weathered and become mixed to some extent with the glacial material, derived largely from the same formations, thus giving rise to the light-colored soil mapped as Volusia silt loam. Over a large part of the county the glacial mantle is so thick that the underlying rocks have had no influence upon the soil formation.

The soil types which owe their origin solely to the weathering of the glacial mantle belong to the Mohawk series. The materials are derived from a wide range of rocks, but the black shales of the Utica and Hudson River formations have contributed so largely to the materials that the black color of some of the types is directly attributable to the influence of these shales. Where the glacial material has been reworked by stream and lake action and redeposited as glacial lake sediments the Dunkirk and Clyde soils are found. With the melting of the glacier temporary lakes were formed in the de-

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pressions at the front of the ice sheet and the volume of water issuing from the ice front carried along rock débris and rock fragments of all sorts and sizes and deposited much of the material in these lakes. The texture of the lake deposits depends upon the rapidity and volume of the streams and the depth and size of the lake. The coarser material, however, like gravel and sand, was usually deposited in shallow water or near shore, while the finer material, like silt and clay, was carried in suspension and deposited in quieter and deeper water. The beds of many of these glacial lakes are at present well drained and weathering has proceeded to a considerable depth. Where such is the case they give rise to the soils of the Dunkirk series. Where they are still swampy and poorly drained the soils have been classed with the Clyde series.

The alluvial soils are of recent origin and represent depositions which are taking place at every overflow along the bottoms of all of the present streams. The largest areas of soils of this group occur along the Mohawk River, and the material in this case represents a wash from and an admixture of material from practically all the soil types of the upland portion of the county.

The following table gives the name and actual and relative extent of each of the several types of soil mapped in the area:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Mohawk clay loam	67,200	25.9	Mohawk loam	7,680	3.0
Mohawk silt loam	45,440	17.6	Dunkirk gravelly loam	7,040	2.7
Volusia silt loam	30,720	11.9	Clyde clay loam	4,480	1.7
Dunkirk fine sandy loam	20,480	7.9	Palatine silt loam	3,840	1.5
Dunkirk clay	17,920	6.9	Dunkirk coarse sand	3,200	1.2
Genesee fine sandy loam	11,520	4.5	Clyde loam	3,200	1.2
Dunkirk loam	8,320	3.2	Muck	1,920	.7
Dunkirk sandy loam	8,320	3.2	Palatine fine sandy loam	1,280	.5
Nellis loam	8,320	3.2	Total	259,200	.....
Rough stony land	8,320	3.2			

PALATINE FINE SANDY LOAM.

The soil of the Palatine fine sandy loam to a depth of 8 inches is a dark-brown to black fine sandy loam, below which, to a depth of about 3 feet, is found a heavy silty loam or a sticky sandy clay of the same color as the soil. Bed rock is usually encountered at a depth of 3 or 4 feet. Sometimes, instead of being underlain by bed rock, there are small areas of the type a few acres in extent where the underlying material is glacial gravel, and when such is the case the type is a little lighter colored than usual. The soil is loose and friable and easily tilled.

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The type is limited in area to about 2 square miles in the northern part of Palatine Township and one or two very small areas farther east. Its surface features vary from rolling to hilly and the natural drainage is good. In times of drought it retains moisture well.

The Palatine fine sandy loam is chiefly a residual soil derived from the Utica and Hudson River shales, broken up somewhat by the ice and mixed with a small proportion of foreign material, but moved only a very short distance or not at all. While feebly glaciated, it is in its most essential respects a residual soil. It is very calcareous and supports a good growth of clover and grasses. Alfalfa can be successfully grown, corn does well, and oats yield a fair crop. Potatoes and root crops do better upon this soil than upon some of the heavier soils of the region. The farms of which it forms a part are in a prosperous condition and the cultural methods are among the best in the county. Dairying is the chief interest. Very little commercial fertilizer is used, but stable manure is regularly applied. Seventy dollars an acre is probably a fair estimate of the average selling price of this soil type.

The following table shows the texture of soil and subsoil of representative samples of Palatine fine sandy loam, as determined by mechanical analyses:

Mechanical analyses of Palatine fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19545	Soil	2.2	7.1	8.0	22.3	15.1	32.1	12.6
19546	Subsoil	.8	6.2	7.4	21.7	12.3	34.9	16.4

PALATINE SILT LOAM.

The soil of the Palatine silt loam, to a depth varying from 12 to 18 inches, consists of a very dark brown heavy silt loam which becomes jet black when wet. Below this and to an average depth of 30 inches the subsoil is composed of a dark-colored slightly heavier silt loam, which becomes a light-textured clay loam in the lower depths. The subsoil rests directly upon the black, thin-bedded, calcareous shales of the underlying formations, and in the lower few inches of the subsoil there are sometimes present a good many soft shale fragments. There are occasionally locations where the underlying rocks come nearly to the surface, and where such is the case the percentage of shale fragments on the surface and throughout the soil is often considerable.

Even where quite heavy the soil is well granulated and is thoroughly drained and easily tilled. Its origin is indirectly due to the absence

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of glacial till, since it overlies the Utica and Hudson River shales, from which it is derived, in all places left exposed after the retreat of the glacier.

The Palatine silt loam is found in relatively small areas throughout the town of Palatine. There are a few very small areas in Mohawk Township and several at different points immediately south of the river throughout the length of the county.

The topography is rolling to somewhat hilly, extensive rock faulting having in some cases made the surface uneven and resulted in considerable range of elevation. Surface drainage is well established and the loose, porous nature of the underlying formation usually provides ample underdrainage.

This type is a residual soil derived from the Utica and Hudson River shales, and not enough glacial material was left to influence materially the characteristics of the soil. The black shales weather rapidly, as is seen in exposed cuts, where a layer of considerable thickness of well-developed soil material is often formed from virgin rock in one or two seasons. A high lime content doubtless aids in this rapid slaking. The influence of the calcareous rock in this soil is indicated by its uniformly dark color and perfect granulation. Some areas of the Palatine silt loam are so shallow that they are seriously affected by drought, but where the soil and subsoil are more than 2 feet deep—even less during a fairly wet season—it is the best corn soil in the county. One hundred bushels of corn is not an unusual yield. The dark color of the soil makes the type warm earlier in the spring than other types, and very likely keeps the soil temperature higher throughout the growing season, a factor that may well account for its special value as a corn soil. Grasses do well and clover gives heavy yields. Alfalfa can be grown successfully. Oats yield fairly well, but this is not a favorite crop for this soil, as it grows too much straw. Potatoes yield well.

The type is mostly included as parts of successful dairy farms, and the methods of cultivation in vogue are those used on the surrounding soils. In most cases they are up to date and progressive. Deep plowing is the rule, and as it is usually considered the best land on a farm careful attention is given to its tillage. Little commercial fertilizer is used and it requires less manure than associated types.

Buildings and fences are mostly in good repair and the farms containing a liberal proportion of this soil are usually in good condition. While there are limited areas too shallow to be of high value at present, they could nearly all be deepened and improved by deep plowing to loosen the surface and expose the rock to weathering. Clovers and some other plants will also assist in the process, as may be seen by the investigation of deep cuts, where various root systems

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are seen in the rock crevices several feet below the surface. Most of the type is valued at $60 to $80 an acre.

The following table shows the average results of mechanical analyses of fine-earth samples of soil and subsoil of the Palatine silt loam:

Mechanical analyses of Palatine silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19541, 19543	Soil.....	0.9	4.2	2.8	8.2	4.3	61.8	17.0
19542, 19544	Subsoil	.4	5.3	4.4	10.1	6.0	48.3	25.4

The following samples contained more than one-half of 1 per cent of calcium carbonate ($CaCO_3$): No. 541, 2.62 per cent; No. 19542, 2.39 per cent; No. 19544, 1.04 per cent.

NELLIS LOAM.

The Nellis loam is a reddish-brown, loose, friable silty loam to a depth varying from 6 to 12 inches, and rests directly upon a hard gray limestone. In small areas the soil covering is so thin that the rock is exposed here and there at the surface, and occasionally such rock exposures were large enough to be shown and in such cases they were mapped as Rough stony land.

With the exception of a very few small areas just above the river bed on the north side, most of the areas are too small to show in the map. A long, narrow strip extends from Palatine Bridge west beyond Nelliston and a small area at the same level is found west of Palatine Church. A broader area is developed at Yosts, on the upland northwest of "The Noses."

The topography is usually flat and level, conforming to the surface of the underlying formation, but often there is a sharp drop or perpendicular ledge of rock separating two levels. Owing to the shallowness of the soil and the nearness of the underlying rocks to the surface, it is a droughty type and crops usually suffer from lack of moisture.

The type is purely residual in origin, being derived from the hard limestones of Lower Silurian age. Occasionally, however, there are local areas where there is a small quantity of glacial material mixed with the type, and in such cases the soil is lighter colored, somewhat deeper, and crops are less liable to be affected by drought. That this soil is still in process of formation, though very slowly, is shown by the rounded, weathered edges of fissures in the exposed rock and by its pitted surface.

The type is not considered a valuable one for general farming purposes, but when the soil is not too shallow it produces a fair pasturage of Canada bluegrass and white clover. There are sometimes very

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small patches where the underlying rocks are 2 feet or so below the surface, and where such is the case grass, corn, oats, and general farm crops do fairly well. The type is devoted almost entirely to pasturage.

The following table shows the average texture of the surface soil of Nellis loam, as determined by mechanical analyses, the subsoil being bed rock:

Mechanical analyses of Nellis loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19537, 19539	Soil.....	1.0	4.5	3.8	10.2	16.2	48.8	15.6

MOHAWK LOAM.

The Mohawk loam to a depth of 10 inches is a brown to brownish-gray loam, below which to a depth of about 36 inches the subsoil consists of a heavy brown loam which sometimes becomes heavy enough in the lower few inches to resemble a clay loam. Both soil and subsoil contain some glacial stones and gravel, and there are a few on the surface, though seldom enough to interfere with cultivation.

This type is found in small areas on both sides of the river, seldom above the 800-foot contour. It usually has a hilly topography, many of the hills being parallel ridges with the Mohawk loam on the crests and other types along the lower slopes and intervening depressions. In the northern part of the county there are two areas which are comparatively level, and here the soil is often too wet for best results. With the exception of these the type is not in need of artificial drainage.

The Mohawk loam is derived from the weathering of glacial débris which was reworked to some extent at the melting ice front by comparatively rapid currents. This resulted in sorting out and carrying away much of the silt that would have made it Mohawk silt loam. This same glacial material where unassorted weathers into the latter type.

In general the Mohawk loam is adapted to general farming crops and to dairying. Corn gives a good yield and 1½ tons of hay are often cut from an acre. Alfalfa can be grown on carefully prepared land. Oats yield 30 to 35 bushels per acre. A few small but thrifty apple orchards were seen. Potatoes yield about 150 bushels per acre. The type is closely associated with the Mohawk clay loam, and the methods of cultivation followed are the same on the two types. Dairying is the chief industry, and the manure is nearly all used to

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advantage. The plowing is fairly deep, and the tillage is usually thorough. In some places commercial fertilizers are being used. Buildings and fences are kept in good repair, and the land as a rule is in good condition.

Most of the type is convenient to the railroad and is traversed by comparatively good roads. The value of farm land varies with the condition of the individual farm, but $45 or $50 is probably a fair estimate of its average selling price.

The following table shows the texture of the fine earth of soil and subsoil of Mohawk loam, as determined by mechanical analyses:

Mechanical analyses of Mohawk loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19519, 19523.....	Soil.....	0.7	5.3	4.7	21.0	18.3	34.0	16.1
19520, 19524.....	Subsoil	1.8	7.2	7.9	15.7	12.8	30.9	24.5

MOHAWK CLAY LOAM.

The Mohawk clay loam, to an average depth of 9 inches, is usually a rather heavy silty clay loam having a dark-brown or grayish-brown color. Sometimes, however, there is enough fine sand to make it a sandy silt loam. The subsoil is slightly lighter colored, but has the usual texture of the surface soil to a depth of 24 or 30 inches, below which it becomes heavier and often darker colored. The latter feature usually occurs where the type directly overlies the soft black Utica and Hudson River shales.

This soil is of glacial origin. Strewn upon the surface and disseminated through both soil and subsoil are varying quantities of subangular and rounded fragments of quartz, granite, and gneiss, with some sandstone and occasionally gray limestone. These stones, which vary in size from small fragments to huge bowlders, are seldom numerous enough to interfere seriously with cultivation. There are some instances, however, where the removal of the larger stones was necessary before the land could be broken, and such fields are inclosed by stone fences. A few soft, black, calcareous shale fragments are found near outcrops and in the soil overlying that rock, but these weather rapidly and do not accumulate in large quantities.

Underlying the type in many places at from 3 to 10 feet is a heavy, plastic, massive blue clay, sometimes nearly 100 feet deep, known as bowlder clay. It is occasionally quite free from stones, but usually contains from 1 to 10 per cent of rounded stones of all sizes, which often show glacial scratches. Most of them are hard blue limestone, foreign to this territory. A few of them are found in the

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immediate subsoil. The greater part of the type, however, overlies bed rock at from 3 to 6 feet.

The Mohawk clay loam is the main type of the western-central part of the county. It occupies the broad slope south of the river to an average distance of about 5 miles, where at about the 800-foot contour it forms an irregular, disconnected boundary with the Mohawk silt loam. North of the river it is also the main type, but is less regular in development and occupies a smaller proportion of the territory.

In topography the type varies from rolling to hilly, and much of it consists of a series of parallel ridges varying greatly in width and length. These ridges are due to the erosional influences of the ice sheet during the Glacial period, and are composed largely of a rock core of shales. The veneering of glacial material varies in depth from a few inches at the crest of the ridges to several feet in the depressions between them.

Owing to the usual rolling surface features, the surface drainage is good. The uniformly heavy subsoil, however, is not favorable to good natural subdrainage, and over most of the type moisture conditions would be greatly improved by artificial drainage. The crests of the hills, where the soil is naturally thin and somewhat mixed with shale, are about the only locations where the drainage conditions are naturally adequate.

The Mohawk clay loam is derived from the weathering of glacial débris deposited as an uneven mantle over the underlying rocks.

It is believed that the material was reworked to some extent by the outflowing currents from the melting ice, but not under a body of water. The dark-colored calcareous shales of the Utica and Hudson River formations to the westward have entered largely into the composition of this glacial material, and fragments of these rocks are found in the soil. It is these dark-colored shales, together with their calcareous nature, which have given the soil its dark color.

The conditions found upon this soil are especially favorable for the dairy industry, and most of it is devoted to that purpose. It is an excellent grass soil, and clovers almost always thrive. Timothy is not always of the best quality, but it yields well. Mixed clover and timothy meadows often produce 1½ to 2 tons the first year, after which the yield gradually decreases until at the end of about four or five years the field needs to be reseeded. This soil produces excellent yields of fodder for ensilage, and when native corn is planted a yield of 60 to 80 bushels is sometimes obtained. Judging from the experiments which have been tried with alfalfa, it is believed that that crop can be grown successfully. It is not particularly an oat soil, but fair yields of that crop may be produced. Buckwheat is seldom sown, except as a secondary or catch crop, to recover the use

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of poorly drained fields after a wet spring has destroyed the corn. A few tomatoes have been grown on the type, and in the vicinity of Fort Plain cucumbers have succeeded. Cabbage can be grown. Wheat was at one time produced extensively, but its production is now practically abandoned in the region. Some hops are still raised in the western part of the area, and they yield well. The soil is not well adapted to potatoes and root crops.

The farmers who live upon this type are usually progressive. The stable manure is carefully saved and applied, and on many farms a manure spreader is used. Deep plowing, careful cultivation, and crop rotation are usually practiced and commercial fertilizer is not generally used. Meadows are sometimes allowed to stand three or four years, then plowed for corn (occasionally two years), sown to oats, and reseeded. A liberal proportion of clover should be seeded in all grass land, seeding especially where the fields are well drained. Most of this type is in good condition and yields profitable returns. The farm buildings are good and fences well cared for.

The value of land varies with its location and condition and the character of the buildings. Farms may be bought for $30 an acre, while others in better condition and near the railroad are sometimes valued at more than $75. A fair average for the type seems to be about $45 an acre.

The following table shows the texture of soil and subsoil of representative samples of Mohawk clay loam, as determined by mechanical analyses:

Mechanical analyses of Mohawk clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19531,19533,19535.	Soil.....	0.8	2.9	2.6	9.1	9.4	49.0	29.9
19532,19534,19536.	Subsoil	.7	2.8	2.9	10.0	10.0	42.9	30.9

MOHAWK SILT LOAM.

The soil of the Mohawk silt loam to a depth of 8 inches is a light-brown silt loam, below which to a depth of about 36 inches the subsoil is a heavy silt loam which passes gradually into a clay loam and is often slightly mottled with yellow, brown, and gray in the lower depths. This type lies between the Mohawk clay loam and the Volusia silt loam in texture, and it grades into one or the other along its margins.

Scattered upon the surface and disseminated throughout the soil and subsoil are found a good many rounded and subangular glacial rocks. These are seldom in sufficient numbers to prevent cultivation,

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though in places they do interfere seriously with tillage. Such areas were indicated upon the map by symbols.

This type of soil is confined to the region south of the Mohawk River and occurs mainly as an irregular broken strip from 2 to 4 miles wide lying on the valley slope between the Mohawk clay loam and the Volusia silt loam. It extends the entire length of the county from east to west. Northeast of Amsterdam there are small spots of soil—too small to be shown in the map—which bear some resemblance to this type.

The topography is rolling to hilly, and sometimes the surface is made up of a series of parallel ridges. In general it has good surface drainage, but owing to the clayey nature of the subsoil there is a large proportion of the type greatly in need of artificial underdrainage. The compact clayey nature of the subsoil causes it to retain too much water during a wet time, while during a dry season the water which should have been carried off earlier by subdrainage finds its way too rapidly to the surface and by excessive evaporation causes deep sun-cracks which aid in baking and drying the soil.

The Mohawk silt loam is derived from the weathering of the thin glacial till deposited as a mantle over the rock formation of the region. It was slightly reworked by outflowing currents from melting ice and differs very little from the Mohawk clay loam in mode of formation, but is generally not as deep and is seldom or never underlain by bowlder clay. The lighter color and slightly lower productive capacity are due to the absence of material derived from the black calcareous shale which influences the darker type. Light-colored shales and sandstones characterize the lighter phase, but where typically developed the soil is composed very largely of foreign material.

Dairy farming is the leading industry upon the type. Clover and timothy give a good yield, mixed meadows of these crops returning from 1½ to 2 tons per acre. Alfalfa requires careful treatment to secure a good stand, but can be grown on parts of the type if properly handled. Oats yield 30 to 50 bushels. Fodder corn does well and native corn yields 50 to 60 bushels. Buckwheat is grown to some extent and yields 30 to 40 bushels per acre; it is an excellent crop for the type, as the extensive root system loosens the compact soil and aids in fitting it for the next crop. Hops are produced successfully in the western part of the county, the soil giving a fair yield of very good quality. Wheat was formerly a successful crop. On a limited area of the lighter textured phase potatoes can be grown if underdrainage is well established and the soil well supplied with organic matter either by stable or green manuring. Buckwheat is of great value in preparing the soil for potatoes. The soil is better for apples

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than the Mohawk clay loam, though not considered a first-class apple soil.

As a rule the Mohawk silt loam is fairly well farmed and the rotation of crops is practiced. Farm manures are made use of in most instances, though on some farms they are allowed to go to waste. Green manuring, which would be an excellent practice on this soil, is seldom resorted to. A few farmers plow deep, but many of them turn only 6 or 7 inches, and some even less. Where shallow plowing is now practiced the depth should be increased about an inch at each plowing until at least 10 inches of the soil is turned. The usual crop rotation is corn, oats, then grass three to five years. A little commercial fertilizer is used on corn and less on oats. It is often found beneficial, but can not take the place of manure. Both stable and green manure are strongly urged for the improvement of this soil.

Most of the type is in good condition. Buildings and fences are in good repair and the farmers are generally prosperous. It has the disadvantage of being farther from market than the Mohawk clay loam, though most of the area is within a convenient distance from the railroad for marketing dairy products. It is not naturally as strong a soil as the darker type, but is adapted to a somewhat greater variety of crops. The average value of the land is placed at $35 to $40 an acre. There are individual farms valued much higher than this and others that can be secured at a much lower figure, the valuation depending largely upon the improvements and state of cultivation.

The following table shows the texture of soil and subsoil of representative samples of Mohawk silt loam, as determined by mechanical analyses:

Mechanical analyses of Mohawk silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19527, 19529	Soil.....	1.0	3.1	2.2	7.6	8.6	53.8	24.6
19528, 19530	Subsoil	1.4	4.8	3.7	11.4	10.6	40.5	27.5

VOLUSIA SILT LOAM.

The Volusia silt loam consists of 6 to 8 inches of a yellowish-brown or pale-yellow silt loam, underlain to depths ranging from 1 to 3 feet by a subsoil of yellowish compact silt loam. The subsoil rests directly upon the bed rocks, and where the depth of the soil mantle is as great as 3 feet the lower depths of the subsoil are often mottled with yellowish, brown, and gray colors. Scattered upon the surface and disseminated through both soil and subsoil are found from 20 to 50 per cent of sandstone and shale fragments, ranging in

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size from small chips to pieces 1 foot in diameter. Occasionally a few rounded stones and gravel of glacial origin are found throughout the type. There are also numerous outcrops of the underlying sandstones and shales. In places the road bed is solid rock showing well-defined glacial scratches. Except for the interference of stone the soil is easily tilled. Where loose stones are so numerous that they seriously interfere with cultivation the condition is indicated on the map by symbol.

Areas of this soil type are found only in the southern portion of the county and at altitudes seldom less than 1,000 feet. A few small isolated areas occupy the tops of the higher hills toward the west. The surface features are hilly, the soil usually occurring on the crests of hills whose lower slopes give rise to other types. It also occurs as distinct, nearly level erosion terraces, sometimes in series, on the sides of hills. The topography affords good surface drainage, but as a whole the soil is springy and wet, so that it is considered a late soil. Crops suffer from an excess of moisture during abnormally wet seasons, and the entire area of the type would be greatly improved by thorough underdrainage.

The Volusia silt loam is largely a residual soil derived from the weathering of the underlying rock formations, whose surface layers were shattered by the passage of the ice sheet over them and the fragments in many cases were pushed along a short distance, but there is a slight admixture of foreign glacial material, as is shown by the presence of the few scattering glacial gravels and bowlders. The relatively high sand content in spots is due to the direct influence of a coarse-grained shaly sandstone, which underlies much of the type and of which fragments are sometimes seen in large quantities in stone fences and in the fields.

Locally the Volusia silt loam is called "yellow loam" and it is generally regarded as a rather poor soil. Golden-rod and daisies are common in pastures and in the fence corners of cultivated fields. Owing to the distance from markets this soil is better suited to stock raising, combined with some grain crops, than to the production of general farm crops. Springs are common in the pastures, so that cattle and sheep can be grazed with very little expense. Stock raising would have an important effect upon the region, as it would require the feeding of all fodder, hay, and other roughage upon the farms and the return of nearly all their fertilizing value to the land in the form of manure. This would greatly increase the producing capacity of the farms for all crops and make possible the profitable growing of grain, potatoes, and other crops in connection with the live-stock industry. Many steep and stony areas, some of which are too shallow or hilly and others too stony to cultivate, it would be better to reforest with trees most valuable for lumber, fence posts, etc.

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At present timothy hay is the most important crop. It is baled and hauled to the nearest railroad or canal point for shipment. Many of the mowing lands have been allowed to stand so long that they have run out, and while some fields yield 1 ton to the acre, the average is much lower. Very little clover is grown. Some dairying is carried on and the milk made into cheese or delivered at skimming stations and only the cream marketed. The skim milk is used for hogs and young stock or made into sizing curd. A few beef cattle, usually of indifferent breeding, are raised, and there is an occasional small flock of sheep. Buckwheat is an important crop and yields 25 to 35 bushels per acre. It is well adapted to the soil and the yields compare favorably with those on other soils in the county. The production of oats is considerable, the yields ranging from 20 to 30 bushels. Hops give light yields, but are of good quality. A little corn is grown, but both climate and soil are unfavorable for the best results. Potatoes are grown only for home consumption, and 75 bushels is considered a large yield.

The agricultural methods on Volusia silt loam are the poorest in the county. The common practice of renting the land to careless tenants and then selling off practically all of the hay and straw instead of keeping stock and feeding these products on the farm has resulted in reducing the yields so low that it is often unprofitable to farm the land at all. Mowing lands are allowed to stand until the growth is too light to cut, and then the depleted soil is plowed only 4 or 5 inches deep, without even spreading on it the manure which has stood behind the barns for an indefinite period. Buckwheat or corn is grown one year, and then oats and grass are sown. An occasional farm is securing good results with more careful tillage, rotation of crops, and better care of manure. But it is a noticeable fact that on this type of soil, which is in greatest need of careful handling and conservation of the manure, there is less attention given to tillage and more manure piles are seen going to waste than in any other part of the area. Commercial fertilizers are used to stimulate the land, but their effect is short lived and often partially destroyed because of poor drainage and lack of cultivation.

It is not naturally as strong a soil as many others in the county. More stock is needed to use the farm products at home. This will increase the amount of manure, which should be spread as thin as convenient, so as to cover a large area and distribute its influence over the farm. Frequent light applications are better for the soil than heavier applications at greater intervals. It should be spread while fresh and not allowed to accumulate in piles where it will either burn out or leach away. A liberal dressing of manure upon sod should be plowed under deep as soon as possible after spreading so that it

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will rot to form humus in the soil. Deep tillage is then necessary to incorporate it thoroughly with the soil.

Buckwheat is an excellent crop to precede potatoes, and if the ground for this has been liberally manured and plowed under deep in the fall, it should produce a good yield of potatoes the next year. Cover crops, like vetch, soy beans, and rye, sown in the fall are excellent to plow under the next spring. Rotation of crops is important. Any convenient system adapted to the desires of the individual farmer may be practiced so long as one crop does not succeed itself too soon. Mowing lands may be left in sod two or three years if the soil is in good condition and a light top dressing of fine manure applied after the second crop is cut, but until the lands have been brought up to a good state of productivity they should not be left more than one or two years without reseeding. The second cutting is often of more value to turn under for green manure than for pasture or hay, especially if it contains much clover. Soiling crops should be introduced to give fresh feed for stock during late summer and to avoid the necessity of pasturing the fields too closely. The soil is supposed by many to be exhausted of its native fertility, but its present condition is due to poor management rather than to actual depletion of mineral plant food.

Buildings and fences are in a tumble-down condition, many buildings being unused and beyond repair. Numerous fields are allowed to grow up to weeds and brush. In some of the abandoned fields hay is still cut in patches where there is growth enough to warrant the trouble.

Land prices run the lowest of any in the county for soils adapted to cultivation. Farms can be bought for $10 or $15 an acre, but few are changing hands. There are probably farms that can be secured for $7 or $8 an acre, and some might bring $30 or $35 an acre. The average value is estimated at $15.

The following table shows the texture of soil and subsoil of fine-earth samples of Volusia silt loam, as determined by mechanical analyses:

Mechanical analyses of Volusia silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19547, 19549.....	Soil.....	1.5	4.4	2.6	9.7	11.3	54.0	16.2
19548, 19550.....	Subsoil	1.6	4.7	3.2	10.1	9.4	54.4	16.3

DUNKIRK GRAVELLY LOAM.

The prevailing characteristic of the Dunkirk gravelly loam is its high gravel content. This varies from 10 to 65 or 70 per cent. The

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fine earth portion of the mass to a depth of 6 or 8 inches varies from a sand to a mellow loam, the color of which is usually brownish or grayish. The subsoil to a depth of 3 feet or more is usually similar in texture to the soil, but the color is a little lighter. Coarse gravels and cross-bedded sands, however, may be encountered at any depth below 1 foot. There are occasionally enough large, rounded, water-worn stones on the surface and in the soil to interfere seriously with cultivation, but most of the type is readily tilled because of its loose texture. A bed of gravel near Yosts included in this type is so loose and droughty that it does not support enough vegetation to warrant cultivation. All along the river the underlying gravel is extensively used for road material and railroad ballast, and just at present there are several large sifting plants where the various grades of sand and gravel are separated for use in concrete work on the barge canal.

The type is confined to the larger stream valleys, and especially that of the Mohawk River, where it occurs principally as a strip less than one-third of a mile in width and adjoins the Genesee fine sandy loam throughout the length of the county on both sides of the river. The surface, with few exceptions, is level or nearly so, but the loose, porous nature of the underlying gravel provides ample and sometimes excessive drainage.

The material of Dunkirk gravelly loam is glacial débris reworked by rapid currents and deposited as marginal drift or alluvial aprons where the streams entered larger bodies of water.

Where the more loamy and deeper soil is of sufficient water-holding capacity to protect it from excessive drought, it is an excellent soil for general farming. Such is the case in the vicinity of St. Johnsville, Fort Plain, Stone Ridge, and on some other river benches, and in most of the upland areas. Corn yields 75 bushels per acre, oats 30 or 40 bushels, timothy and clover hay 1½ tons, and other general crops do well. It returns a good yield of hops. Where the soil is especially shallow, coarse textured, and droughty, the land is used only for pasture. An area of this kind occurs near Yosts.

The portion of this soil under cultivation is well farmed; plowing is fairly deep and tillage thorough, and though a little commercial fertilizer is used, stable manure is depended upon as the chief source of fertility. The increased use of the latter can not be too strongly urged, especially upon loose, coarse-textured fields where its decay to make humus also greatly increases the water-holding capacity of the soil.

The value varies from a few dollars an acre for the coarse-textured droughty areas to $75 for some of the better farming lands.

A mechanical analysis was not made on account of the extremely variable texture of the soil, which makes it impossible to secure a representative sample.

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DUNKIRK COARSE SAND.

The Dunkirk coarse sand is a loose, friable, yellowish or brownish sand with a depth of 3 feet or more. The sand is of all grades, from very fine to coarse, and occasionally there is present a small quantity of rounded gravel. The surface 10 inches is slightly more loamy and darker colored than the material below, owing to the incorporation of organic matter by tillage. In cuts this material is seen to extend to a depth of 5 feet, and it is probable that as a rule it is much deeper than this. It usually rests upon a heavy stratified chocolate clay, but often there are thin strata of gravel above the clay. It is an easy type to cultivate and it is almost entirely under the plow.

The largest area of the type occurs west of Fonda and extends westward, thence to within 1 mile of Yosts. Another area is found at Tribes Hill and a very small area at Port Jackson. The surface features are level, and owing to the loose, open nature of the soil and subsoil the drainage is excellent.

The Dunkirk coarse sand owes its origin to reworked glacial débris deposited in lacustrine expansions of the river when its waters were held above the present level by glacial or postglacial dams. It was afterwards exposed to weathering by the receding of the water, and has been modified through the ages to its present condition.

Land of this type of soil is peculiarly adapted to the growing of truck crops, early potatoes, onions, berries, and other crops demanding earliness in spring and thorough drainage, but it is not a good soil for producing such crops as are required on a dairy farm. Clover and grasses do not thrive, and corn and oats return light yields. Onions, berries, and general gardening are the present special interests, though only on a small scale and in connection with general farming. Commercial fertilizer is used and stable manure is cared for and used to the best advantage. More of such manure is needed to add humus to the soil and to aid in making it more retentive of moisture. Buildings and fences are in excellent repair and the farms have an appearance of prosperity. This is due in a large measure to its location with respect to markets. It has an estimated value of $50 or $60 an acre, though few farms are for sale at this price.

The following table shows the texture of soil and subsoil of representative samples of Dunkirk coarse sand, as determined by mechanical analyses:

Mechanical analyses of Dunkirk coarse sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19497, 19499.....	Soil.....	4.7	38.2	18.5	14.2	5.0	13.5	6.6
19498, 19500.....	Subsoil.....	4.8	35.7	21.6	16.8	8.5	11.9	6.9

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DUNKIRK SANDY LOAM.

The Dunkirk sandy loam consists of 10 inches of brown sandy loam, underlain to depths varying from 2 to 3 feet by gray or yellowish-brown material of about the same texture as the surface soil. Thin strata of cross-bedded sand are often found in the subsoil and stratified clay underlies much of the type at depths varying from 2 to 10 feet. A few rounded stones are found, but they are seldom numerous enough to affect cultivation. Owing to the sandy nature of the soil it is an easy and agreeable one to plow and cultivate.

The largest area of the type is found in the northwest corner of the county, in the vicinity of East Canada Creek. Another large area occurs on the eastern slope of the Garoga Creek Valley, and there are several other detached areas east of that place. East of "The Noses" escarpment there are several small areas on both sides of the river, but the only large one occupies the east slope of the Cayadutta Valley, extending northwest from Fonda to the county line.

Irregular slopes and small conical hills form the greater part of the areas of this soil, though there are areas, like the East Canada Creek delta, which are rolling to level. Drainage is often excessive, though there are shallow areas overlying clay or rock that carry an excess of water in wet seasons.

The Dunkirk sandy loam owes its origin to reworked glacial débris deposited in lacustrine expansions of large glacial streams when the waters were held above the present stream levels by glacial dams.

Fair yields of hay and corn can be raised with careful management, but the soil is not well adapted to these crops. The average yield of hay is less than 1 ton per acre, and 50 bushels of corn is considered a good yield. Oats yield 25 bushels per acre. General farming is not as successful upon this soil as upon some others in the county. The soil, however, is a good type for potatoes, of which it should yield 100 to 150 bushels with reasonable care, and their quality should be high. Root crops, gardening and truck crops, and small fruits and berries can be grown successively. Some stock, however, should be kept on every farm. Cover crops and green manures, particularly legumes, are of great value to soils of this character. In all farm operations the aim should be to return to the soil all possible organic matter. Considerable commercial fertilizer is used, and the crops respond readily to its use. It is believed, however, that greater benefits would follow if this were used in connection with green and stable manures.

Where this type of soil prevails the region is not settled as thickly as in other places and the condition of buildings and fences, as well as the general appearance of farms, indicates a lack of prosperity. Land located conveniently to markets and shipping points can be

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secured for $15 or $20 an acre, but the average valuation of land of this character should be about $25 an acre.

The following table shows the texture of soil and subsoil of a fine-earth sample of Dunkirk sandy loam, as determined by mechanical analyses:

Mechanical analyses of Dunkirk sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19501	Soil	2.7	15.3	10.2	26.0	13.4	23.3	9.1
19502	Subsoil	3.6	12.4	6.5	23.3	11.4	35.9	7.0

DUNKIRK CLAY.

The surface soil of the Dunkirk clay is a light-brown loamy clay varying in depth from 4 to 12 inches, but with an average depth of about 7 inches. In places it has a slight chocolate color, and in poorly drained depressions it is of a dark-brown color. The subsoil to a depth of 36 inches or more consists of a reddish-brown or chocolate-colored heavy plastic clay occasionally showing thin-bedded stratification. Stones, gravel, and coarse sand are very seldom found. The soil is very compact and sun-cracks readily. Owing to its compact nature and its tendency to bake upon drying it is a very difficult soil to till and must be carefully handled, for if plowed either too wet or too dry it may be so packed and clodded that several seasons are required to restore good tilth.

The Dunkirk clay is found in small areas in all parts of the county except in the region of Charleston. Its usual topography is level to gently rolling. Sometimes, however, it occupies slight, well-drained depressions. It is also sometimes found as the remnants of a series of terraces on the slope of a hill and not infrequently it extends from a higher terrace up over the crest of the hill. The surface drainage of the soil is usually good. Subdrainage, however, is almost lacking because of the impervious nature of the subsoil. Tile drainage is necessary in order to secure the best results. Tiling the land would not only remove the excess moisture but would improve the texture of the soil, and thus in dry seasons crops would be less likely to suffer so much from drought. The loamy character is also increased and the structure improved by cultivation and the incorporation of organic matter.

This soil owes its origin to reworked glacial débris deposited in the deep, quiet water of lakes, which were held at various high levels by glacial ice dams.

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Timothy hay, the crop to which this soil is best adapted, yields from 1½ to 2 tons per acre. Clover does not do especially well, but is of great value in improving the texture of the soil when a good stand can be secured. The soil is not naturally well adapted to corn, but an attempt is made to grow the crop because of the demands of the dairy interests. Where well tiled, well manured, and thoroughly tilled it can be made to produce from 50 to 60 bushels of corn per acre. Oats will yield about 30 bushels per acre. Some buckwheat is grown, of which the average yield is about 25 bushels per acre. This crop is of considerable value in improving the mechanical condition of the soil. The soil is not adapted to potatoes, root crops, and fruits, being too stiff and refractory.

In general the agricultural methods followed upon this type are good. But little commercial fertilizer is used and stable manure is employed extensively. The soil is strong and productive, but because of its heavy texture and compact structure, which make tillage difficult and exaggerate both wet and dry conditions, it is not adapted to a wide variety of crops. This defect, however, can be remedied by underdrainage, deeper plowing, and the liberal use of manure and other coarse organic material. The plowing should be deep in order to secure a deep loose surface. Where shallow plowing has been practiced the depth should be increased about 1 inch each time, until 10 inches is reached, and even a greater depth of soil will not be injurious. A fair estimate of the average value of land of this type is about $25 or $30 an acre.

The following table shows the texture of soil and subsoil of fine-earth samples of Dunkirk clay, as determined by mechanical analyses:

Mechanical analyses of Dunkirk clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19505,19507	Soil.....	0.8	4.2	2.8	7.9	5.6	37.3	41.6
19506,19508	Subsoil	.7	2.2	2.0	6.7	6.1	29.5	52.9

The following sample contained more than one-half of 1 per cent of calcium carbonate ($CaCO_3$): No. 19508, 2.68 per cent.

DUNKIRK FINE SANDY LOAM.

The soil of the Dunkirk fine sandy loam is a brown or grayish-brown fine sandy loam 10 inches deep. The texture of the soil, however, sometimes varies from a silty loam to a sandy clay loam. The subsoil is usually a fine sandy loam or heavy sandy loam of brownish-gray color to a depth of 3 feet or more. There is likewise considerable variation in the texture and color of the subsoil material. Parts of the type are underlain at some depth by a brown, gray, or chocolate-

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colored clay. Where the subdrainage is poorly established the lower part of the 3-foot section is often mottled yellowish and drab or gray. Where the type is immediately underlain by the black shales of the Utica and Hudson River formations the black color of these shales modifies the color of the subsoil. Very often lenses of fine sand and clay are found at different depths in the subsoil. The type is easily tilled. Waterworn stones, ranging in size from small particles to 6 or 8 inches in diameter, are usually present on the surface and throughout the soil and sometimes in the subsoil, but seldom is the quantity of these sufficient to impede cultivation.

Areas of Dunkirk fine sandy loam occur only in the eastern part of the county. The main body begins at the escarpment north of "The Noses" and extends eastward. It is also found south of the river in the vicinity of Auriesville and Amsterdam, and there is a small area at the extreme eastern end of the county.

The surface features of the type vary from level to rolling. Surface drainage is adequate over most of the type. Where the subsoil is open to a good depth there is also good natural underdrainage, but in places where a heavy subsoil is found at shallow depths artificial drainage is necessary. Three miles north of Amsterdam is an area where an unusually level topography and heavy impervious subsoil combine to make artificial drainage desirable. Over most of the soil, however, favorable moisture conditions are easily maintained throughout the growing season.

Dunkirk fine sandy loam owes its origin to reworked glacial débris which was deposited in temporary shallow glacial lakes. The spots of heavy clay subsoil represent depositions in quiet water, while the coarser materials represent the work of shifting currents during more active periods.

The Dunkirk fine sandy loam is adapted to the general farm crops of the region. Hay yields from 1 ton to 1½ tons per acre, oats 30 to 50 bushels, and corn 50 to 70 bushels. Potatoes can be grown successfully on the lighter phase of the soil and cabbage and other heavy truck crops do well. It is the best apple soil in the county, but care should be taken to insure good underdrainage before setting out orchards on the more level areas.

The region occupied by this type of soil is in a prosperous condition. The farms are convenient to markets and are generally in a good state of cultivation. Deep plowing and thorough cultivation are practiced and the importance of crop rotation is recognized. Some commercial fertilizers are used, but stable manure is depended on as the chief means of maintaining fertility. Buildings and fences are in good repair. Farm values range from $30 an acre in the northeast to $60 or $75 for some of the better farms farther west.

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The following table shows the texture of representative samples of soil and subsoil of Dunkirk fine sandy loam, as determined by mechanical analyses.

Mechanical analyses of Dunkirk fine sandy loam.

[Fine earth.]

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19485, 19487	Soil.....	1.8	10.5	7.1	20.3	14.9	33.9	11.3
19486, 19488	Subsoil	2.7	8.8	6.9	18.5	18.7	18.8	10.9

DUNKIRK LOAM.

The Dunkirk loam consists of 8 inches of light-brown silty loam, underlain to a depth of 36 inches by a lighter colored material similar in texture to the soil. Sometimes, however, the lower depths of the subsoil become drab or yellowish brown in color. A few stones are usually found on the surface and through the soil mass to a depth of 3 feet. This soil is quite loose and friable and easily tilled.

Important areas of the type occur in the vicinity of Amsterdam, and other smaller areas are associated with the Dunkirk fine sandy loam on both sides of the river east of "The Noses" escarpment. The areas consist of rolling lands with an occasional sharp slope. Drainage is usually well established and artificial drainage would be beneficial only where the soil overlies a heavy subsoil or in small local depressions.

The Dunkirk loam and Dunkirk fine sandy loam are so closely associated in every way that only by careful examination of the texture can they be distinguished. The origin of both types is the same.

Hay, oats, and corn return good yields and in general the soil is adapted to the general farm crops of the region. Dairying is the chief interest. The methods and conditions are similar to those upon the Dunkirk fine sandy loam. The average value of the type is about $35 an acre.

The following table shows the texture of fine-earth samples of soil and subsoil of Dunkirk loam, as determined by mechanical analyses:

Mechanical analyses of Dunkirk loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19493, 19495	Soil.....	0.3	2.2	1.6	12.2	20.2	39.9	23.6
19494, 19496	Subsoil	2.2	7.1	6.4	19.9	13.4	36.9	13.5

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CLYDE LOAM.

The soil of the Clyde loam varies in texture from a heavy sandy loam to silty loam, is nearly black in color, and ranges in depth from 12 to 18 inches. This material is underlain to a depth of 3 feet or more by a stiff, plastic, impervious blue or gray clay loam, often mottled with brown or yellow.

Areas of this type of soil are found in all parts of the county. They are flat or depressed and poorly drained. There is no natural underdrainage and the surface is in places under water throughout the wet season of the year, except where artificial underdrainage has been provided.

The surface soil is the partially weathered product of an accumulation of glacial, alluvial, and colluvial material, often increased by organic matter from the decay of vegetation. The dark color is due to partly decayed organic matter under wet conditions. The subsoil is lacustrine in origin, and represents the finer particles of the glacial débris deposited in glacial lakes.

Most areas of the type are undrained and are included in pastures. A few of the larger areas have been drained by surface ditches and made to produce fair yields of corn, oats, and hay. If thoroughly tile drained the yields of these crops could be greatly increased in both wet and dry seasons. Where the surface soil is more than 1 foot deep it is of sufficient value to warrant thorough tile drainage, which would fit it for the production of most of the general farm crops of the region and make it compare favorably in value with the associated soils. At present it ranges in price from $5 to $14 an acre, with an occasional area which has been artificially drained valued at $30 or more.

The following table shows the texture of a fine-earth sample of soil and subsoil of Clyde loam, as determined by mechanical analyses:

Mechanical analyses of Clyde loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19479	Soil	0.2	3.9	6.9	25.1	15.5	39.0	10.1
19480	Subsoil	.0	1.7	2.8	9.8	9.2	45.7	30.9

CLYDE CLAY LOAM.

The soil of Clyde clay loam varies in texture from a heavy sandy loam to a clay, and ranges in depth from 2 to 6 inches. It is high in organic matter and is usually dark colored. The subsoil to a depth of 36 inches or more is composed of a bluish clay loam. Where the

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subsoil has had some chance to weather it is sometimes slightly mottled with light-brown and yellowish spots. The type is difficult to till even when drained, and must be worked at just the right time to prevent the soil running together.

The Clyde clay loam is found in poorly drained depressions in all parts of the county. Its surface is flat or slightly lower than surrounding areas. The soil is the partially weathered product of an accumulation of glacial, alluvial, and colluvial material, to which is added the accumulated organic matter resulting from decaying vegetation. The subsoil is lacustrine in origin and represents the finer particles of the glacial débris deposited in glacial lakes. The land is usually wet and unsuited to cultivation. When drained, however, it is a fair grass and small-grain soil, though too heavy for corn or vegetables. Buckwheat is of great value to the soil in improving its structure, and the straw should be plowed under, together with all other coarse material available. It usually affords good pasturage, and most of the type is best adapted to this purpose. Alone its value is very low, but for pasturage in association with other types it is very conveniently used, and such areas, unless of considerable extent, do not materially influence the selling price of a farm.

The following table shows the texture of soil and subsoil of a fine-earth sample of Clyde clay loam, as determined by mechanical analyses:

Mechanical analyses of Clyde clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19483	Soil	0.2	6.6	3.8	12.08	5.6	47.5	23.6
19484	Subsoil	.2	1.6	2.3	9.5	8.5	42.3	35.6

MUCK.

The type Muck consists of an accumulation of dark-brown or black decayed organic matter intimately mixed with fine particles of soil washed from higher lying areas. It ranges in depth from 1 foot to 3 feet or more, but the usual depth is about 18 to 24 inches. The subsoil to a depth of several feet consists of a blue or a mottled gray and yellow, plastic, impervious clay or sandy clay, in many respects identical with the subsoil found under some of the Clyde soils.

Muck is found in all parts of the county in depressions where surface drainage is inadequate to remove the water at any season of the year and the subsoil so impervious as to form a basin where water can collect. Some ferns, mosses, water grasses, and certain varieties

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of trees thrive in such places and their dead parts mingle with the soil and partly decay to form the black, spongy, organic mass. So long as it remains wet there is a continual addition from year to year, but when drained and allowed to dry out the volume greatly decreases by the loss of moisture and by the rapid oxidation of the organic matter. A few of the larger areas if thoroughly drained and put under cultivation would produce excellent celery, onions, potatoes, cabbage, and root crops. With a few exceptions, however, the areas are too small to warrant reclamation. Muck areas are mostly wooded or included in pastures and should remain so. Some areas could be partially drained with profit to insure the better growth of pasture grasses. Very little, if any, of it is under cultivation and its value is very low. Few areas are large enough to affect the value of the farm in which they are included.

GENESEE FINE SANDY LOAM.

The Genesee fine sandy loam consists of a loose, friable dark-brown fine sandy loam with a depth of 3 feet or more. The surface 10 inches of the material is somewhat more loamy than that immediately below, owing to additions of manure and the effects of cultivation. Adjacent to the banks of the streams the type in small areas is sometimes somewhat more sandy than is typical, owing to depositions left during overflows. Farther away from the stream banks in slight depressions or old sloughs the type sometimes approaches a clay loam in texture.

The largest areas of the Genesee fine sandy loam occur as bottoms along the Mohawk River. Smaller areas of less typical material border the Garoga, Otsquaga, Canajoharie, Flat, and Schoharie creeks. Some of these bottom areas, notably along the Schoharie Creek, have been long free from overflow and are much lighter in color, occasionally a dark yellow or very light brown. In places along these smaller streams the areas are narrow and badly cut by erosion, and the soil is shallower than usual. Such eroded areas are sometimes stony and gravelly.

Though usually flat, the Genesee fine sandy loam is well drained and the moisture conditions are for the most part favorable for crops throughout the growing season. The type is derived from the weathering of alluvial deposits laid down at times of overflow. There are a few areas which have not been covered with water for many years, but the greater part is subjected to annual inundation. Higher lying places are only reached by an occasional flood. Each flood leaves a thin deposit upon the surface and adds to the organic content of the soil.

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The soil is naturally a productive one and its fertility is maintained by the periodical additions of organic matter from overflow. It is an excellent corn soil and used largely for that crop. Yields of 100 bushels are common. The annual overflows prevent the use of fall-sown crops on much of the type, but grass makes an early start and good yields of hay are secured. Oats often yield 50 to 60 bushels and seldom prove a failure. Buckwheat is occasionally grown, but is not needed as a soil renovator and its use is seldom advisable, except as a catch crop in case of a late flood. Potatoes are not produced extensively, but with proper care should yield 150 to 200 bushels per acre. Cabbage, tomatoes, and garden truck can be made profitable crops near the larger towns and shipping points. The smaller areas in upland valleys have similar adaptations where large enough and so situated as to be easily accessible, but many of them are so small and irregular in shape that they are adapted only to pasturage.

Some of the best-managed farms in the county are situated partly upon this type and in general the cultural methods are good. Deep plowing and thorough cultivation are the rule. Crops are rotated and the mowing lands seldom left long enough to deteriorate. The type is mostly under cultivation—even small islands in the center of the river—and fields are rarely left in permanent pasture. Very little commercial fertilizer is used. Some stable manure is spread upon the fields in the spring, or, if spread in the fall, plowed under before the water rises. Fall cover crops are of value in that they hold sediment from the overflow water, thus adding to the organic content of the soil.

Few farms are located entirely upon the Genesee fine sandy loam, but most of it is included in farms occupying mainly the adjacent slopes, which are often steep and best suited to pasturage. It is recognized throughout the county as one of the strongest soil types.

Many areas of Genesee fine sandy loam are valued at more than $100 an acre, though the average should probably be placed a little below that figure. The value of upland valley areas varies from $25 to $50 an acre, according to the location, extent, and improvements.

The following table shows the texture of soil and subsoil of a representative sample of Genesee fine sandy loam as determined by mechanical analyses:

Mechanical analyses of Genesee fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19515, 19517	Soil	0.9	4.3	4.0	26.7	18.8	34.4	11.0
19516, 19518	Subsoil	.1	.8	.8	28.7	30.7	28.2	10.1

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ROUGH STONY LAND.

Rough stony land includes areas not adapted to cultivation or any farming utility other than pasture. It includes steep, rocky hillsides, rocky slopes, stony bottoms, bare rock surfaces, and other areas upon which it is impossible to plow and plant crops. There are small patches included in the type which could be cultivated, but they are limited in extent and surrounded by nonarable land and could not be shown in the map. Most of the Rough stony land occurs as the bluffs and steeper slopes along the river, on the west side of Schoharie Creek, and the gorges of smaller streams. Some of it furnishes a little pasturage, but the type is of very low agricultural value, and in the sale of farms it is not rated with the arable land. Some of it is wooded, however, and the value of such areas depends entirely upon the quality and quantity of the growth.

SUMMARY.

Montgomery County is situated in the heart of the Mohawk Valley, in the eastern-central part of New York State, and doubtless represents better than any other one county the soil and agricultural conditions of this region. The Mohawk River crosses it from west to east, and the easy grade of its valley bottom has been taken advantage of in the construction of two great transportation systems, the Erie Canal and the New York Central Railroad, which reach across the State.

The topography is, in general, very rolling to hilly, but with many local level areas of considerable extent. A series of ridges of remarkable uniformity in shape and position is most briefly described by the term "corrugated" applied to the section occupied by them. It is most pronounced south of Canajoharie and around Charleston Four Corners, but is noticeable to some extent throughout the county.

The drainage waters all enter the Mohawk River either directly or through tributary streams and are carried by it to the Hudson, through which they reach the Atlantic Ocean.

The climate is typical of a large part of central New York. The summers are normally mild, with an occasional one remarkable for excessive heat or abnormally cold nights. There are usually from one to three months of severe winter weather.

The first white settlement was made early in the eighteenth century. The early agriculture was very crude. As greater areas were cleared and transportation facilities increased, the county became an important grain region for a short time. Dairying was one of the early interests and has come to be the most important industry. A large production of hay, grain, and other crops, however, serves to balance the agriculture and relieve it from the danger of over-

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specialization. In 1900 a net return of $1,688,296 was realized upon a total investment of nearly $13,000,000 in land and equipments, or in rough numbers $700 per farm with an average investment of $5,400.

In general, the agricultural conditions in the county are progressive. Crop rotation is practiced, manure is carefully used, and deep plowing and thorough tillage prevail. The slack methods and lack of intelligent management in some sections and on individual farms in all sections lowers the average returns, but, on the other hand, the success of individual farms in those regions generally considered poor is ample evidence of the possibilities of the county.

The farm lands range in value from $7 to $100 an acre, with an average of about $25 for the county, not including improvements.

All stages of glacial-soil formation are represented in the county. The Palatine and Nellis soils are residual from the underlying formations, very slightly influenced by glacial material. The Volusia silt loam is the feebly glaciated product of the underlying rock. The Mohawk soils are glacial till, containing varying amounts of transported material from rocks found within the county. The Dunkirk and Clyde soils are derived from glacial outwash material deposited in former temporary bodies of water.

The Palatine fine sandy loam is very limited in extent, but is well adapted to alfalfa, corn, and general farm crops.

The Palatine silt loam is one of the best corn soils in the area where not so shallow as to be droughty. It is also excellent for alfalfa and clover.

The Nellis loam is thin and droughty, but supports a remarkable pasture considering its shallow depth. The deeper phase when more than 2 feet deep is a fair general farming soil.

The Mohawk loam is mostly used for dairying but is a good general farming soil.

The Mohawk clay loam is an excellent dairy soil and is mostly devoted to that interest. Corn yields 50 to 75 bushels, hay 1½ to 2 tons, oats 30 bushels. Alfalfa can be grown and all clovers thrive.

The Mohawk silt loam is composed more largely of foreign material than any other type of glacial origin. It is a good dairy and general farming soil, and has a slight preference over other types for oats.

The Volusia silt loam is considered the poorest farming land in the county. It is in poor condition, due to improper management, but can be restored to a much higher state of productivity by improved cultural methods and the institution of agricultural methods and interests better adapted to the region.

The Dunkirk gravelly loam is variable in texture and adaptations, but the better areas not droughty by reason of coarse underlying

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beds of gravel are adapted to the crops of the region and are highly valued for general farming.

The Dunkirk coarse sand is a poor dairy and general farming soil, but is well adapted to special truck crops and market gardening, for which it is used to a large extent.

The Dunkirk sandy loam is a good late potato soil, and if properly handled should return good yields of excellent quality.

The Dunkirk clay requires careful handling for corn and general farm crops, but is an excellent soil for timothy hay, which normally has a brighter color than that grown on other soils.

The Dunkirk fine sandy loam is adapted to the general crops of the region and is the best apple soil in the county.

The Dunkirk loam differs very little from the fine sandy loam type in adaptations and interests.

The Clyde loam and clay loam and Muck are all of limited extent and of little importance. Some areas could be profitably drained and put under cultivation, but in their present condition they are adapted to little but pasturage.

The Genesee fine sandy loam is considered the best soil in the county. It returns excellent yields of all spring-sown crops, but is mostly used for corn and oats.

Some of the territory mapped as Rough stony land is conveniently used for pasturage, while a portion of it can be best utilized for forestry.

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A RECONNOISSANCE SOIL SURVEY OF NORTHWESTERN PENNSYLVANIA.

By HENRY J. WILDER and GUSTAVUS B. MAYNADIER, assisted by CHARLES F. SHAW, of the Pennsylvania Agricultural Experiment Station.

INTRODUCTION.

The area selected for the first reconnoissance soil survey in the Appalachian Mountain and Plateau Region of the United States embraces eleven counties of northwest Pennsylvania, viz, Erie, Crawford, Mercer, Lawrence, Warren, Venango, Forest, McKean, Elk, Potter, and Cameron. This block has an area of 8,112 square miles. The northwest county—Erie—includes Pennsylvania's only shore line bordering on any of the Great Lakes. The area, moreover, is not only representative of three broad sets of soil and agricultural conditions which are typical of much more extensive soil

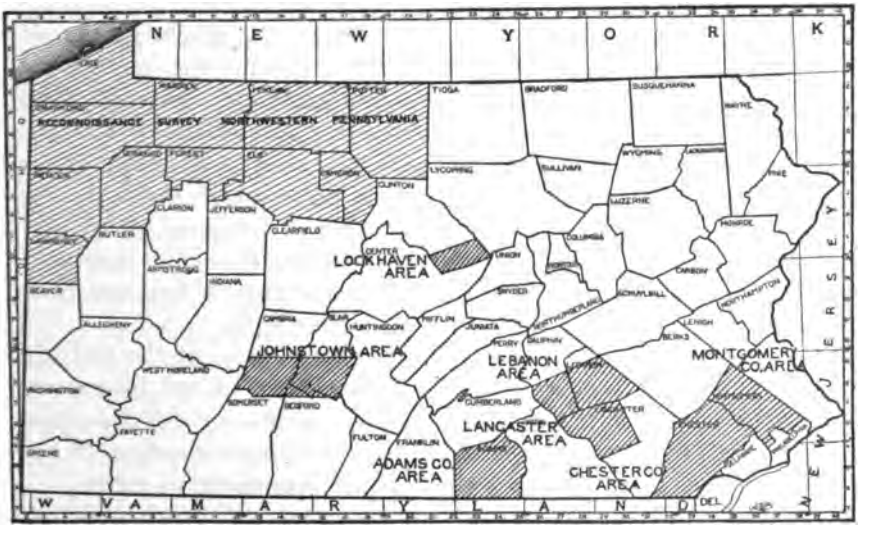

FIG. 4.—Sketch map showing location of the reconnoissance survey, northwestern Pennsylvania.

areas in southwestern New York, northwestern Pennsylvania, and northeastern Ohio, but it is also, for an area of its size, exceptionally illustrative of the great diversity in soil conditions and corresponding crop adaptations of this section.

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SOILS.

The soils of northwestern Pennsylvania are classified into five main upland series, with two series of terrace soils along the streams. As the latter series correspond to the first and second terraces, it follows that either or both of them are lacking in very many cases, as the stream cuts are often sharp. A few poorly drained areas along streams or lakes were mapped as Meadow or Swamp.

Considered in chronological order of formation, which is to-day strongly marked by the topographic sequence of the region and even by the agricultural growth, the oldest group of soils extends entirely across the southern part of the area. This section was formerly a lofty plateau with a level surface, so far as local variations were concerned, but it was a part of the roof of the great Appalachian system, constituting, in fact, a part of its westerly slope—the Allegheny Plateau—except in the northeast part of the area, where it extends easterly over the crest of the great Appalachian Divide, and includes the headwaters of the West Branch of the Susquehanna River.

The surface of this plateau was made up mainly of a cap of Pottsville conglomerate and, where such was wanting, of gray and yellow Pocono sandstones, the thin bed of shale separating these relatively thick formations not having sufficient exposure to be of importance in the forming of agricultural soils. Where the above geological formations have been eroded through by streams the underlying materials encountered were less resistant, and the resulting deep dissections of the present disclose the softer formations of Catskill and Chemung. Of these, the first mentioned now forms many of the valley slopes and has been the determining residual factor in the derivation of the present soils of the lower levels of this lofty plateau. The Chemung is seen only in the valley beds, and is usually covered to such depth with alluvial material that it has had little or nothing to do with the formation of surface soils.

From the red sandstone and red shale formations of the Catskill the Upshur soils have been derived, but the rest of the formations mentioned have given rise to the Dekalb series—by far the most extensive group of soils in this locality, and representative of the light sandstone and shale soils of the whole Appalachian region.

Advancing from the north, glaciers extended well up this plateau slope and deposited over it a mantle of soil débris gathered here and there, under widely divergent conditions, from a variety of geological and soil formations. At the northern limit of the Dekalb soils the halting and melting of the approaching glacier left a terminal moraine—a dump of complex soils and soil-formative materials gathered from the diverse formations over which the ice sheet had taken its course.

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The uniformity with which the glacier advanced to the south, regardless of surface contour, whether hill or dale, is highly suggestive of the incomprehensible energy with which this rigid and enormous mass moved forward. Grinding down and scraping off hills, filling in hollows and valleys, the glacier upon its final recession left a till which varied greatly in depth. Covering the region frequently to a depth of many feet, it has left a determining impress upon the character of the present soils and in such case gives rise to types of the Volusia series. The till covering of the old plateau, however, becomes thin at higher altitudes and in exposed places, where the glacier ground off closely and deposited little material, and often gives rise only to the surface soil, the underlying shales or sandstone being the parent rock from which the subsoils are derived. In fact, even surface soil of glacial origin is in places missing, the evidence of glacial activity being shown at present only in the stria seen on the bed rocks in exposed places or by a sprinkling of bowlders, or possibly by both. Wherever the surface soils even are glacial in origin the Volusia series has been mapped.

There are many areas, however, particularly near the southern glacial limit, yet north of the terminal moraine, where soils of glacial origin are altogether wanting, and other areas where such material is too thin to be the determining factor in the formation of the soils. Where possible, on the scale of map used, these areas have been separated as the Warren series, for they differ not only in origin and general character from both Volusia and Dekalb soils, but also to a marked degree in crop adaptation and value. On a map made 1 inch to 1 mile additional areas of the soils of the Warren series could be shown, and this would be an important separation from the Volusia series, but on the present scale it is necessary to depend on description only for all except the large continuous areas, though others of importance occur, particularly in the northwestern part of Warren County.

The Warren series is derived from blue, blue-gray, or slate-colored shales and flaggy sandstones of the same colors, the latter usually being thin bedded, though in some cases they occur in considerable blocks. These shales and sandstones belong undoubtedly to the Conewango formation, which has been mapped and named in an unpublished report by the United States Geological Survey in the Conewango Valley in the eastern part of Warren County, and they correspond in age, probably, to the Catskill formation, farther southward toward the center of the State, and also to the derivative material of the Upshúr soil areas shown in the eastern part of the accompanying map.[6]

[6] This information was supplied through the courtesy of Professor Butts, of the United States Geological Survey.

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The formative shales of the Warren soils are, however, the clay shales, thus differing from the type shales of the Conewango Valley, where they are sandy in character and give rise to a different class of soils. These clayey shales form heavy soils, viz, loams, silt loams, silty clay loams, and silty clays.

North of the Volusia soils, or Lake Erie escarpment, the bed-rock shales are deeply covered by unconsolidated sedimentary lake deposits, which constitute the Dunkirk series of soils. These latter are the youngest soils in this part of the State of Pennsylvania, except the terrace and bottom soils along the streams.

The following table gives the names and areas of the several soils shown in the accompanying map:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Dekalb soils	2,945,280	56.7	Wheeling soils	68,480	1.3
Volusia soils	1,786,880	34.4	Upshur soils	61,440	1.2
Genesee soils	160,960	3.1	Huntington soils	1,600	.1
Warren soils	85,120	1.6			
Dunkirk soils	81,920	1.6	Total	5,191,680	.....

LAKE-FRONT SOILS.

DUNKIRK SOILS.

The only Dunkirk soils in the entire area occur in Erie County, where they occupy a belt from 2 to 4 miles wide along the southern shore of Lake Erie. They are thus seen to be the lake-front soils, and in topographic features bear the characteristic marks of a plain of sedimentary soils generally level, but marked with a succession of old lake beach lines of low relief at varying distances apart. From the high land to the south progressively toward the present shore line of Lake Erie each of these old terrace lines is, of course, a little lower than its predecessor, the only sharp change in slope being at the highest lake level, where a steep rise of the Erie escarpment terminates the lake-shore belt toward the south.

The shortest way to a clear understanding of the important, even if not strikingly marked, topographic features of this section is by a very brief résumé of their geologic formation.

During late glacial times the entire Lake Erie Plain section was lake bottom, and at its greatest extent this body of water is designated by geologists as Lake Whittlesey. That is, Lake Whittlesey may be considered as the greatest extension of the present Lake Erie at an earlier geological period, when the lake waters stood at their highest level. Of this ancient glacial lake a definite shore marking

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remains, between which and Lake Erie the Dunkirk soils are encompassed.

As the waters of Lake Whittlesey gradually receded many indefinite beach lines, or rather a series of slight ones, indicate a succession of lowerings of the lake level. The maintenance of the water level for a considerable geologic period along a bluff at present marked by the Ridge road allowed the formation of that very definite shore line. At this stage of recession the waters are known as Lake Warren. The many beaches, bars, and deltas formed in and by these waters not only have much to do with the surface configuration of the present time, but also control the character and distribution of the soil formations and their adaptations to crops.

In Bulletin No. 106, New York State Museum, Professor Fairchild states concisely the relationship of these important topographic features, as follows:

> The total vertical spacing of the Lake Warren bars is about 50 feet. The interval of 45 feet between Whittlesey and the upper Warren and 25 feet between the upper and lower Warren is a fair example of the prevailing relation as far as the Whittlesey extends.

The streams for the most part flow directly across the lake plain, and in transition from one terrace to another the stream course is often deeply cut, the bed-rock shales being exposed to a considerable depth. In fact, the underlying shales are seldom covered very deeply by the lake sediment soils in any of this region, and in places they form the present subsoils.

All the surface soils of the Dunkirk series, and in most places the subsoils also, consist of sediments deposited in Lake Erie when it stood at higher levels than at present, any extended halt in the course of the shore-line retreat being now marked by beach or terrace lines, which give a sharp aspect to the present surface features.

The surface configuration has proved a determining factor in the development of the section, for along these shore-line ridges or bluffs all the main highways have been placed; and it is beside these thoroughfares that the towns, villages, and farmhouses are principally located, the last either in little groups or scattered, as the case may be.

The Dunkirk soils are very complex in texture, in crop adaptation, and in value. All grades of soil from coarse to fine, including all the recognized classes, occur, not in heterogeneity, but usually in well-defined areas. That is, the fine sand, medium sand, and coarse sand; the fine, medium, and coarse sandy loams and loams; light and heavy silt loams, clay loams, and clays were found, as well as combinations of many of the above classes, with fine or coarse gravel.

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The only illustration of, or tendency toward, grouping of these diverse classes of soils, when considered as a whole, is the predominance of sandy soils near the center of the belt on each side of the city of Erie, while in the eastern and western parts of the county loams and clayey loams prevail.

The occurrence of so many variations in the soils accounts for the marked differences in crop adaptations even in local areas. Specific adaptation of soils to crops is readily observed not only with general farm and market-garden crops, but especially so in the case of grapes, the leading money crop.

The effect of variation in the soil upon the growth and character of vine, yield and quality of the fruit, as well as variation in the respects stated with different varieties thereof, is apparent. Such problems, however, could only be outlined, not worked out in detail, in a reconnoissance survey of this character, just as it is not possible to show on a map of the scale used the locations of the various classes of soils of the series, that being left for a more detailed survey.

The color of the Dunkirk soils includes the light and medium shades of brown and gray and also the darker yellows. In slightly depressed areas, where organic matter has accumulated to such extent as to give the soils a very dark-gray or black color, the Clyde series is found. Of these areas the largest is between West Springfield and the Ohio line. Of importance also are two areas in Fairview Township, and one just beyond the southwestern limit of the city of Erie.

The cropping system followed on the Dunkirk series has been traced through the successive stages of development in the remarks made on the agricultural history of the region. In recent times the crop yields have been, generally speaking, at least moderately good, and special crops have shown varying stages of success upon the different types of the Dunkirk series. The range in crop yields, however, upon the different types is so great that any definite estimate for the series as a whole would be entirely misleading, and so is omitted.

In tillage operations the Dunkirk soils present the widest possible range in scope as far as textural conditions are concerned, though the heavy members of the series are less stiff in structure than the corresponding types of some other series, and hence do not present as serious difficulties either in preparation or cultivation tillage. As a whole the Dunkirk soils are easy to work.

Considering the soil series as a whole, however, it may be said that the Dunkirk soils are generally deficient in organic matter. Sandy members of the series in the vicinity of Erie are said to have been little more than "blow sand" originally, or as soon as the first few

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crops had been removed. Good methods of farming during the stock-keeping period then greatly increased the humus content and brought these soils into a productive condition. The "ups and downs" in the tillage history of a great part of these soils, due to change in temporary conditions of agriculture or simply to change in ownership, or from proprietary to tenant farming, have left many fields deficient in humus, and they are again in some cases reverting even to the blow-sand condition.

A similar field history has left many of the heavy Dunkirk soils in a poor state, the depletion of the organic matter reducing them to such condition that clods readily form and bake hard. Such conditions do not prevail, of course, in well-kept vineyards, but where these soils are used for general farming this condition is only too prevalent.

The soils of many individual fields in the Lake Plain are "acid," though this is a condition not generally heeded, particularly by the tenant farmer. This acid condition is true not alone of the heavy members of the series but also of the sandy and gravelly soils. The prevalence of plants which thrive best in acid soils, such as the sorrels and common plantain, shows clearly that lime is a prime requisite in many cases for the most successful crop growth.

The cause for poorly farmed and unproductive areas in the Dunkirk soils is, superficially at least, almost entirely economic. A remunerative agriculture until the early seventies of the last century established a standard of land values commensurate with profitable returns from such lands. Since that time competition with free government virgin lands, which have to a considerable degree been taken up by foreign immigrants accustomed to live on an economical basis, has reduced the profits of general farming until such use of the soil is no longer profitable except on those types especially adapted to the general farming crops. This has caused a direct loss to landowners, except where they have been able to produce some crop so well adapted to special soil conditions and markets that the crops from the newer lands above referred to are not a seriously competing factor. A constantly readjusting schedule of land values in the district has, of course, naturally ensued. In many cases it has been impossible for the farmer to extricate himself from these appending conditions, but again he has been sufficiently observant to interpret the trend of conditions in time to readjust operations so as still to get remunerative returns from his soil. It is a mastery of special adaptations of soils to crops, together with a study of market conditions, that must determine the status of farming on these very desirable soils.

The range in price of the Dunkirk soils is very great, according to location and improvements, but from $50 to $300 an acre is represent-

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ative. The price of farms with a high percentage of the land in vineyard is often much higher, good vineyards bringing $500 an acre or more.

UPLAND SOILS.

VOLUSIA SOILS.

The Volusia soils occupy almost the entire western tier of the counties surveyed, being separated from Lake Erie only by the narrow strip of Dunkirk soils, and terminated at the southeast corner of Lawrence County by the Dekalb uplands. Extending thence northeasterly in the form of an arc of a circle these soils pass into New York, but reenter Pennsylvania in the northeast part of the reconnoissance area, where they occupy a part of Potter County. The southern boundary of these soils, marked in many places by the débris of the terminal moraine, is thus seen to be shaped nearly like a half-moon, if its course be followed for a distance into the New York counties, Chautauqua, Cattaraugus, and Allegany, and thence back through Potter County, Pa.

All of the western division of these Volusia soils lies on the slope of the great Allegheny Plateau, already outlined under the heading "Soils;" but the eastern division as it returns to Potter County, Pa., from New York, lies on the eastern slope of the great Appalachian Divide. Thus the reason for the half-moon shape of this soil-series occurrence becomes at once apparent, i. e., the great glacial mass in its approach to the southward was split as it struck the sharp northerly median line of this Appalachian spur and followed lines of less resistance closely around the lower slopes on both sides of that mountainous mass of hard and highly resistant rocks. The glacial débris thus literally flowed around on both sides of the relatively high Appalachians, just as a river's waters are separated by a narrow island and flow along its sides.

The bed rocks of all this northerly slope of the Allegheny Plateau, as at present exhibited both in old and modern stream cuts, and also where the glacial mantle is too thin to conceal their character, consist of shales and sandstones, variable in texture and color; but the shales greatly predominate on the lower-slope exposures over which the glacier extended, the sandstones being in the majority on the upper slopes.

Over such rock and resulting soil conditions then swept the great glacial mass, planing down the hills and filling in the valleys with the débris it carried. The drainage of the country was thus materially altered and the direction of some of the streams reversed. The soils, however, were most affected by this glaciation.

Evidence of the enormous power of the advancing glacier is clearly shown by the fact that the ice front occupied the valleys and uplands

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alike and advanced over each to a nearly equal degree until checked by the highest plateau masses of the Appalachian system. The front of the great arc of the glacial advance is nearly a smooth line and glacial tongues extended along the valleys only slightly beyond the points attained at the highest elevations.

The general advance was checked against the plateau wherever the altitude of the land mass greatly exceeded 2,000 feet. In Potter County the moraine reaches a higher elevation (2,580 feet above tide) than elsewhere in the United States, according to Professor Lewis, and there crosses a great continental watershed on the different sides of which the headwaters of the Allegheny and Genesee rivers and Pine Creek have their source, and flow thence into the Gulf of Mexico, Lake Ontario, and Chesapeake Bay.

After the glacier had reached its maximum advance and began its retreat the surface of the land was covered with a layer of "till," which in some places is of considerable depth and in others grades down until it becomes comparatively thin. This till sheet is composed of the ground-up and reworked underlying shale and sandstone materials mixed with the detritus brought down from the north by the ice. The soils derived from this glacial débris are, for the most part, fine textured, constituting usually silt loams, loams, or clays.

Wherever the glacier in the course of its retreat halted for any length of time moraines were formed. These are composed of the heaped-up deposits of detritus carried along by the glacier and piled up at its front as it slowly moved to that point, and melting, dropped its load. These morainic materials are extremely varied in character and size of particles, but are generally coarser grained than the till, and give rise to sandy loams, stony sandy loams, and stony loams.

In view of these facts two broad generalization divisions of the Volusia soils may be made—the yellow-brown morainic soils and the gray soils deposited with comparatively even spread, while the glacier maintained at least a steady, even, though slight, advance or retreat.

Topographically the morainic sections are very much more broken than the broad expanse of the heavy Volusia soils, being marked by a succession of hills, hummocks, and kettle-holes; while occasional long, sinuous ridges—eskers—or their broken and interrupted remnants are at once evident or may be readily traced.

On account of the difference in thickness of the glacial deposit, streams were dammed up and their courses changed. In this manner the somewhat numerous small lakes and swampy areas of the Volusia soil region were formed. Of the lakes some are shallow and others deep, according to the depth of "till" damming the ancient stream course. In some cases these lakes have deepened their outlets appreciably, thus becoming partially drained to form swampy areas.

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The deep drift areas of the Volusia soils are rarely rocky or stony, but erratics either isolated, frequent, or even numerous occur over small areas. Occasional fields have many cobbles and rounded stones. The morainic areas, on the other hand, are usually stony or gravelly, and large bowlders are found in different locations on them.

The stones and bowlders vary greatly in character, as would be expected, since they have been collected from diverse sources, and vary in size from pebbles to large rock masses. Many of the bowlders still bear glacial scratches.

The predominating color of the Volusia surface soils of this area is gray, the large areas of the silt loam often being a light gray and the clay loam a darker gray, the ashy brown colors being comparatively rare; while in the loam and in the morainic soils the yellow and brown shades may only change the character of the gray, or entirely obscure it. The subsoils are gray, yellow, and brown, or mottled gray and yellow in color. In swampy areas and in minor depressions the surface soils have become black or dark gray, while the subsoil has been bleached to an ashy whiteness. In some regions where drainage is markedly deficient, even though on well elevated tracts, the whole soil section has become very light colored, in fact almost ashy.

The loam, silt loam, and clay loam are best developed on the broad, level or very gently rolling areas, though these are all found also on the steep hillsides. On steep areas the soils are generally stony, the stones consisting largely of small flaggy sandstones or thick blocks of shale rock. In steep cuts along streams, gullies, and roadways the underlying shale rock of the region often exposes its fractured strata, these generally being only slightly tilted.

Aside from the morainic soils, the silt loam, loam, and clay loam constitute most of the general drift soils of the Volusia series.

Representative samples of the Volusia silt loam consist of from 6 to 8 inches of gray or brownish-gray silt loam resting on a subsoil of light-gray or mottled yellow and gray silty clay loam, pale-gray silt, or silt clay. The clay content of the lower subsoil usually increases with depth, a clay texture replacing the silty clay loam and silt; hence the soil section often includes three well-defined soil classes in successive layers.

Crop yields on the silt-loam areas vary widely, corn ranging from 20 to 50 bushels, oats 15 to 45 bushels, and wheat from 8 to 20 bushels, though there is little of the latter grown.

Clay-loam areas consist of light-gray to dark-gray or brown clay loam, with an average depth of 9 inches, underlain by gray or yellowish-brown silty clay. Where well farmed, such soil will yield 35 to 50 bushels of corn, 20 to 35 bushels of buckwheat or oats, and from 12 to 16 bushels of wheat; but with poor farming these soils

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become cold and clammy, with the result that the yields are much less than those given. After being seeded for two years "white grass" takes possession of the sod, and in many cases is mowed or pastured for several or many years without rebreaking. As a result, the general yield of hay is extremely and unnecessarily low on both the silt loam and the clay loam.

On these soils drainage is markedly deficient and must be artificially established before crops can be profitably grown. The field history of an actual case will serve to illustrate present soil conditions on these soils:

In 1863 a young man bought a farm of 230 acres, and had no difficulty in producing good yields of corn, cereal grains, etc. Neither had he more trouble from frosts than was experienced in sections which are now in better agricultural condition. The land was newly cleared and the soil was mellow and in good tilth, on account of the stored-up organic matter and the temporarily efficient drainage made possible by the passages through the soil of the decaying tree roots. Gradually these avenues of drainage filled, the supply of decayed vegetable matter was steadily depleted as a result of short-sighted and thoughtless methods of cropping, and the soils became hard, intractable, and sour; and then corn would not mature. "The seasons have changed," is the explanation offered by the owner, and the one often assigned by farmers generally for the much greater injury to crops from frosts than forty years ago. But the change in the season has taken place below and not above the surface of the soil, for the failure to maintain adequate drainage in these soils prevents their aeration and greatly retards their warming up in the spring, thus greatly shortening the season. Owing to the late start crops get in the spring on this account they are much more liable to injury from early frosts in the autumn.

On farms where the crops have been fed to stock, and where both crops and stock have been well managed, the soils are still in satisfactory condition; but where crops are sold directly the soils have steadily deteriorated, a small yield of hay has been about the only money crop, and the soils have lost the mellow character which the original supply of organic matter gave them.

The loam soil which is associated with the silt loam and clay loam often presents a far different aspect. A more modern and prosperous type of farming goes with soil which lends itself more readily to tillage operations than does the silt loam or clay loam, and it is everywhere evident that this soil appeals to the farmer as being warmer and more productive than those types. It certainly is far more responsive to the average methods followed in the Volusia region. The soil of such areas consists of mellow brown loam to an average depth of 10 inches, traces of shale often being present in local areas. The

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subsoil consists typically of yellowish-brown loam or drab silty loam, either of which sometimes grades into a clay loam. Local areas have considerable small gravel, cobbles, and stones on the surface. The last seldom exceed a diameter of 3 to 5 inches, and are seldom present in sufficient amounts to interfere seriously with tillage operations.

With good farming methods this soil yields in a particular instance 100 bushels of corn on the ear, when the clay loam brings 75 bushels. The yield of oats is much better on the clay loam. Wheat does best on the loamy areas, as the clay-loam average is lowered by heaving in unfavorable seasons. Timothy excels on the clay loam and clay areas, but clover is much more successful on the loam.

In all the classes mentioned stony areas often occur of sufficient extent to be separated on the usual scale of mapping, such conditions usually occurring in the more steeply rolling or abrupt locations. At the foot of slopes along valleys gravelly loams are found where morainic material is mingled with wash from the hillsides. In one case the lateral moraine is so thrown across a valley as to fill it for a considerable distance, leaving a succession of knobs, peaks, and little ridges, which are very low in agricultural value. In Potter County the morainic material extends for a considerable distance with an approximate width of one-half mile to 1 mile, the most representative soil being a gravelly sandy loam.

As the topography smooths out to the northward the region, while showing glacial action, has not received sufficient soil débris to control the series, and the soils derived from the underlying blue-gray shales are extensive enough in one case to be mapped as the Warren series, while over areas of some importance in the southern part of the Volusia soil belt the till is shallow, often only a foot or so deep.

East from Ulysses, on high elevations, the soils have been derived from flaggy sandstones, the deposit of glacial material being of little importance or entirely wanting. If in place these soils would have belonged to the Dekalb series, but the flaggy sandstones have been broken up to considerable depths, and with the soils have been churned up by the ice until they are more properly included in the Volusia soils.

In the north tier of townships of Potter County—Harrison, Bingham, and Genesee—the soils are only thinly glaciated and contain local areas of the Warren soils. These soils differ from those of the Volusia series both in texture and appearance, and on the whole are more productive. The soils are improved with excellent farm buildings, but the recent tendency has been to allow them to decline slightly. Such farms can be bought at about $30 an acre, and at that price offer good opportunities for investment. It is the above character of soil that is found around the headwaters of the Genesee River, though the sources of the river are rather high up on the

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plateau. On these soils corn is seldom frosted and dairying is the principal industry.

The prices of Volusia farm lands in general range from $15 to $50 an acre, and in exceptional cases even more, but a fairly representative range is from $20 to $40 an acre, including a reasonable amount of farm improvements.

WARREN SOILS.

The failure of the glacier, along or near its southern extension, to leave in places any débris as soil covering, or at least not enough to determine the soil character, has left a residual soil from sedimentary rock north of the line marking the southern glacial limit. These soils have not before been mapped and are now named as the Warren soils. The Warren soils are derived from the Conewango formation (so named here through the courtesy of the United States Geological Survey in supplying unpublished data), which here consists principally of gray shales and thin-bedded, fine-grained sandstones. The lowest layers which outcrop in the region are the Chemung, which sometimes appear at the water's edge in the deepest stream cuts, but are unimportant in the formation of the soils. Above these shales the Conewango formation comes in, which in turn is overcapped by carbonic or yellow-brown sandstones, shales, and conglomerates, from which the Dekalb soils are derived. Thus the Conewango corresponds probably to the Catskill formation of central Pennsylvania, which there gives rise to the Upshur series of soils.

The Warren soils extend in Warren County from Bear Lake southeast nearly to Warren and from Bear Lake southwest to the county line, whence they continue through southeast Crawford County and to a point near Bradleytown, in the northwest part of Venango County.

The boundaries of this area are somewhat arbitrary, as they are not sharply drawn in places, and in a survey of this kind time was not taken to work such a separation out in detail or in merely local occurrences. Many isolated areas of the Warren soils exist, both along the line of glacial boundary and also for some distance back therefrom and within the generally glaciated area where the till soils are absent.

The Warren soils are entirely different from the Volusia soils derived from the true glacial till, in that they are residual soils derived from shales and thin-bedded, fine-grained sandstones. In fact, bedding planes are oftentimes in evidence in the soils themselves, not having been ground up or disturbed by glacial action.

The Warren soils are for the most part of clayey rather than sandy character, the loam, silt loam, and clay loam prevailing, with

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a silty clay loam predominant, while the sandy members have at most only local representation. A characteristic section of the silty clay loam of the Warren soils consists of 6 to 10 inches of silty clay loam, medium gray in color, resting upon a subsoil of heavier silty clay loam, which in color is commonly a lighter shade of gray than the surface soil. It is not rare, however, to have the same medium or even dark-gray color prevail throughout the subsoil.

The structure of these soils differs markedly from that of the Volusia soils, a characteristic of vital import in their adaptation to crops, the differences in working, and the different treatments required. The silt loam of the Warren series, to illustrate, is well adapted to potatoes, similar to the silt loam of the Penn series, whereas the silt loam of the Volusia series in its undrained condition is not so adapted, but the Volusia loam is. Stony areas were encountered in the Warren soils only on steep eroded slopes generally along sharply cut stream courses, and are for the most part insignificant in extent. The marked differences between these and the Volusia soils, in many cases indicative of the agricultural superiority of the former, show the necessity for separating them wherever possible, and their occurrence is not too complex for such to be practicable on the next larger scale which would show accurately their relationship in the area and also the accompanying crop development.

The Warren soils range in depth from 3 to 10 feet, or even more, and though not yet fully appreciated they are productive where well farmed. As a whole, they are better farmed now than the Volusia silt loam. They are more easily worked than the silty Volusia soils, are not so illy drained, nor so deficient in organic content. They thus constitute soils above the average for economic improvement, and on them may be found attractive opportunities for farm development and investment. Farm prices range from $25 to $45 an acre, and good farms may be had at $30 to $40 an acre, including ample improvements.

DEKALB SOILS.

Of the total of 8,112 square miles surveyed the Dekalb soils occupy 4,602 miles. These soils form an almost unbroken stretch in the central part of the area mapped, lying in truncate form, the complemental apex of which lies across the New York boundary, the whole forming the great northern extension of the Dekalb soils of the United States.

The transition from the Volusia to the Dekalb soil region is very striking from an agricultural viewpoint, for the wooded and undeveloped condition of the latter suggests at once a newly settled country in which the resources are only just beginning to be exploited. A more thorough examination, however, reveals the fact that pre-

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liminary farming experiments have long since been tried, but the results have been so unpromising under the stereotyped methods pursued, as compared with other regions, that little has been accomplished. Several factors have contributed to these results, but one of the most vital causes is the character of the soils of the region and their lack of adaptation to the type of general farming to which certain other soils, such as the adjoining Volusia series, for instance, are so well adapted.

The soils of the Dekalb series having been formed principally from the weathering of hard rocks—Pocono sandstone and Pottsville conglomerate—highly resistant to the agencies of disintegration and decomposition, have accumulated slowly even on the level or tilted parts of this elevated region. Hence the soil formations are seldom deep, but, where not affected seriously by erosion, they are sufficiently so for successful agriculture.

The form of the original plateau surface, however, is in many places so cut up by erosion that level areas are rare, and the surface ranges from shallow dissected areas to a succession of very steep hillsides. Sharp crested ridges and V-shaped intervening valleys oftentimes occupy continuous areas of no mean extent, and again not infrequently separate the more level upland areas, which represent the ancient face of the plateau. On the steep surfaces soils have had little chance to gather, but in local spots deep soils sometimes occur in pockets along the lower slope or in the valleys. The soil-forming materials, however, have been in great part rushed down the stream courses as fast as disintegration has taken place, leaving a sharp, angular topography, devoid of the rounded surface contours to which a condition of accumulating soils gives rise.

The surface color of the Dekalb soils is some shade of yellow-brown, a medium yellowish brown being perhaps the most characteristic shade. Where derived from the coarse-grained sandstones and conglomerates, the white or very light-colored medium and coarse grains of sand give a light-colored, lifeless appearance to the surface soil. The fine-textured sandstones usually give a darker soil. Garden spots and occasional well-farmed fields are dark brown in color, because of the presence of greater amounts of organic matter. Such isolated examples are the best available illustration of the course which should be followed in the attempt to improve these soils.

The subsoils of the Dekalb areas are typically yellow, or light brown, but there are many local spots where they are reddish yellow or yellowish red. Where poorly drained, gray and pale-yellow mottling occurs, but such conditions are rarely found in areas at all extended.

The stone content of the Dekalb soils depends almost entirely upon present topographic conditions. On level areas disintegration has

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taken place with a good deal of uniformity and the resulting soils are rarely stony. Steep areas, on the other hand, are often very stony.

The range in texture of the Dekalb soils is fully as pronounced as with the Volusia soils, but very much less so than with the Dunkirk soils. On some of the generally level areas the heavy classes of soils, such as loam, clay loam, and silt loam, predominate, but large areas of fine sandy loam occur, and, in fact, this is perhaps the prevailing class of soil on the least broken areas. This soil is a light, medium, or dark brown fine sandy loam to an average depth of 10 inches. This may be underlain by yellow, brownish-yellow, or reddish-yellow clay loam, or between the two there may be a layer of yellow sandy loam. The latter occurrence is the less desirable for many purposes.

The subsoils of the heavy classes of soils, such as the loam, silt loam, and clay loam, are almost always clay loams, yellow being the predominant color. These subsoils are often close-textured, but rarely stiff, though in places the content of fine sand is sufficient to constitute a fine sandy clay. The Dekalb soils include many stony areas, these occurring most frequently as the stony loam and stony fine sandy loam, the stony fine sand and stony clay loam being of less extent.

In the valleys and bottoms where the Dekalb soils occur they are usually of the sandy types, ranging from fine sand to fine sandy loam, and as a rule are quite free from fragments of stone. The valley areas are usually narrow strips.

On the reconnoissance scale of mapping it is manifestly impossible to attempt to cover fully by description the local conditions of the region occupied by any given series, but representative conditions of a section thereof may well be substituted to illustrate a comprehensive whole.

In Venango County, for example, the section between a line drawn from Oil City to Maple Shade and the east county line is principally rough stony land, stony loam, and stony fine sandy loam, with minor areas of loam, medium sandy loam, and clay loam. In this region there is almost no agriculture, oil being the only interest of importance, now that the timber has been largely removed. In the vicinity of Cranberry and Seneca, however, just to the west of the above district, there is a good agricultural area. The soils consist principally of loams, silty loams, and clay loams, all being moderately well farmed. The land is here level to gently rolling, in marked distinction to the sawtoothlike topography to the east of it. The location of a good state road through these soils assists in making this a promising region for a higher type of agricultural development than is feasible on a great deal of the Dekalb soils, but at present most of the farms are punctured with oil wells—a feature

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which instantaneously dissipates any mental attitude on the part of the landowner for agricultural development.

In the vicinity of Dempseytown the loamy soils of the Dekalb series form the basis for a good agricultural district. These soils occur on a level plateau fragment where erosion has not been seriously destructive. A heavy silty loam is the prevailing soil type, though fine sandy loam, clay loam, silt loam, and even clay are all represented. These soils, particularly the loam, support some good dairy farms where near enough to a market—Oil City or Franklin—to drive with milk. The large farms are devoted principally to dairying, while the smaller ones are used almost entirely for gardening to as great a distance as 10 miles from Oil City or Franklin. The greatest degree of prosperity is seen on the farms used for dairying or garden crops.

Bordering the stream courses the country is deeply dissected and filled with steep hills and fewer ridges. It is back away from the stream courses along the divides that erosion has been less severe and left a semblance of plateau which offers very fair possibilities for agriculture.

Where oil products are at all promising, land is held at fabulous prices; e. g., a good dairy farm of 200 acres has not been sold at an offer said to be $60,000. Some oil wells are at present yielding oil. But a farm a mile distant was held in the same way until, from near-by borings as a basis, the opinion was formed that the farm would not yield profitable wells. Farm buildings worth several thousand dollars were allowed to go to decay, and almost nothing is done with a farm formerly good and which might be made good again.

In the northeast part of the county, north of the Allegheny River and east of Oil Creek, the surface is much broken. Stony loam prevails, but there is also some rough stony land. Around Plumer the land is only moderately hilly and there are a few moderately good farms.

Much of the rough land is covered with a scrubby second growth, and even if cleared it can be bought for $3 an acre. An occasional well-improved farm may bring from $20 to $40 an acre, but most of the farms are cheap, as there is thought to be little money in farming.

In sections of this character late spring frosts and early fall frosts often injure crops, thus making the safe cropping season very short, greatly restricting the crops grown and even preventing any extensive production of corn. As a result many farmers have practically eliminated corn from their list of crops. The principal crops grown are oats, which bring an average yield of 20 bushels per acre, and buckwheat 15 bushels, while the yield of wheat ranges from 10 to 15

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bushels per acre. Tree fruits seldom bear a full crop, owing to injury from frosts.

In Forest County only a small proportion of the land is agriculturally developed. Harmony, Tionesta, and Green townships are largely forested, the oil industry being well developed in Harmony. Green Township is practically a wilderness of second-growth forest, and in the eastern part large areas have been burned over. In such tracts desolation reigns supreme, as a stunted growth of woodland sprouts prevails in which every tree of appreciable size has been killed by fire.

The soils of this part of the county are mostly Dekalb stony loam or Dekalb stony fine sandy loam, with here and there a spot of loam or clay loam. In the southwestern part of Jenks Township, just south of Gilfoyle, and in Barnett Township, around Redcliff, the plateau is not deeply dissected, and the land lies well for tillage, being only gently rolling. These soils, which are for the most part the loam and fine sandy loam with subsoils of sandy clay or clay loam, support a few good farms, and might well support many more. Eventually such areas are certain to be more intensively farmed. A noticeable feature of the Dekalb soils throughout this area, and, in fact, of a somewhat more extensive area than is included in the present survey, is that generally speaking the sands are finer in grade than farther south in the Appalachian Dekalb soils. The coarse grades of sand were seldom found in the present survey, except where erosion has been active on the steep slopes and the finer grades of sand have been washed down the slopes.

The Dekalb soils occupy most of the southern half of Potter County, in spite of the fact that the geological column shows much red shale and red sandstone. This is due to the deep dissection which most of the region has undergone. The walls of the synclinal valleys, particularly where of appreciable breadth, are for the most part of red shale and red sandstone. These give rise to soils of the Upshur series, but they can rarely be shown except along the main stream courses. The red soils usually extend a third of the way or more up the hill, which gets steeper and steeper, and so it is oftentimes just the Upshur soils of the lower slope that are farmed. On the other hand, the red Upshur soils sometimes extend entirely up the slope and include the hilltops. In such cases the hills are more rounded along the top of the slope than are the Dekalb hills, the break of the latter often being abrupt. These Upshur hills are always a little lower in elevation than the highest Dekalb hills, whose surface of white sandstone or conglomerate usually rests upon a layer of red shales, etc., which give rise to the Upshur soils where the uppermost capping of the Dekalb hills is wanting.

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When considered as a whole, this region has been so deeply dissected and weathered that the red soils have become mingled with those derived from gray, yellow, or brown shales, white sandstone, etc., until the red color no longer prevails. In fact, the boundary between these two soil series in this part of Pennsylvania will always have to be determined by mapping the prevailing color, as extensive areas are made up of beds of alternating colors, rendering their separation expensive beyond reason in general work.

In the eastern part of Potter County, along the contact with Clinton County, and also somewhat farther north with Tioga County, the sawtoothlike topography is very deeply dissected, making a great part of the land worthless for agriculture. Much of this region would be mapped as steep broken land. The timber has all been removed, a growth of brush from 2 to 6 years old occupies the ground, and the region is desolate. Occasional areas have been burned over, increasing the barrenness. Such areas are adapted only to forestry.

The prospect for oil has led to the drilling of countless wells in the Dekalb region, a goodly number of which have shown profits ranging from high to low, but abandoned derricks of unsuccessful "dry" wells, or wells not sufficiently productive to warrant a continuation of pumping, dot the landscape in many localities. The present desolateness of such areas should be overcome by reforestation, the only economic procedure whereby they may again be a source of profit.

In locating the Dekalb-Volusia boundary in northeast Potter County the character of the soil has been made the determining factor. Hence the soil boundary is somewhat north of the southern glacial limit, which coincides on the geological map with the southern occurrence of glacial bowlders, as they are so scattering that they should be considered only as erratics on residual soils.

The topography, too, presents many soil complications which would appear on a larger scale map. For some distance on either side of the series boundary as mapped all the steep slopes are Dekalb or, in some cases, Upshur, while the hilltops are Volusia. For example, along the border south of Ulysses the ravines from the Dekalb series to the southward head up into the Volusia plateau, and thus only the original plateau top is Volusia. The ravines wherever steep sided, as they mostly are, have the Dekalb soils, and thus cross the glacial boundary as determined by Leslie for a considerable distance into the Volusia district.

In Cameron County the soils are mainly Dekalb, the silt loam, clay loam, sandy loam, and shale loam being most extensively found. Upshur soils also occur in small areas, and, together with the bottom lands, comprise the most fertile soils of the region.

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The whole area of Dekalb soils surveyed includes an ever-recurring succession of topographic, soil, and agricultural conditions of which the preceding descriptions are representative.

The influence of soils on the character of agriculture is strikingly shown in this region, as the Dekalb-Volusia boundary determines the farming boundary as well, the Volusia being largely tilled and the Dekalb principally forested.

Considering the Dekalb soils in their entirety, areas representing in the aggregate a large percentage of the total are not adapted to agriculture under present conditions, and should be permanently devoted to systematic forestry.

On the more level areas good farming soils occur, some of which have been moderately well developed, but many more have not had a tithe of their possibilities brought out.

Whenever there shall be demand for farm products in this region, or this lacking, whenever land becomes higher in price outside, the Volusia region for example, these Dekalb areas will be effectively and profitably farmed.

Unfortunately for the Dekalb region, the opinion is commonly held that because it is more or less broken in surface features, hilly, and mountainous in places, and inasmuch as timber products, oil, and other natural resources are at present of first importance, there is no opportunity for agricultural development. The region is adapted to the growth of hay, potatoes, and buckwheat. Clover should do well, but in most cases the soils require liming for its growth. This has been tried by few, and consequently many farmers have failed with this crop.

The crop yields under the general methods of farming now followed are low; corn or oats bring an average of 20 bushels per acre, buckwheat ranges from 10 to 20 bushels, and potatoes from 40 to 75 bushels. Improved methods of management, such as efficient working, effective crop rotation, including as many legumes as possible, especially red clover, and fertilization should increase the yields to 30 or 40 bushels of corn, 30 bushels of oats, 15 to 25 bushels of buckwheat, and 75 to 125 bushels of potatoes.

A fact of the utmost importance in considering the use to be made of these soils is the isolation even of many of the reasonably level areas, due to their being practically cut off from markets, transportation facilities, etc., by deeply dissected areas of such extent as to make transportation of farm products across them unfeasible. As a result many areas of such location should be included with the rougher portions for forestry. To the extent of supplying local markets, the soils adapted to farming yield good financial returns and also offer opportunities worth while for producing many special products which are now shipped into the region, such as small fruits,

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garden crops both summer and winter, hay, and in some instances dairy products. Shipment outside the area is in some cases not practicable because the railway is too far distant, in others because freight rates are prohibitory for such use, and in others because of the steepness rather than the distance of the haul to the railway station.

Generally speaking, ordinary farm crops grown under present conditions can not compete in the open market with the same crops grown on more productive soils more advantageously located with reference to direct markets or satisfactory and cheap shipping facilities, such as may be had in some sections of the Volusia soils within the area surveyed.

UPSHUR SOILS.

The Upshur soils are of importance only in Potter and McKean counties, where in the main they form strips along lower slopes, though they sometimes extend entirely up the slope and even over flat or domelike hilltops.

The Upshur soils are dull red in color, having been derived from red shales and sandstones of the Pocono, Catskill, and Chemung formations. These soils occur mostly in synclinal valleys, which form a network all over the region; but while the formation can be traced far up the small streams and rivulets, their area in such cases is, of course, unappreciable. These soils usually ascend one-third the way, or more, up the slope which gets steeper and steeper. So it very often happens that only the lower slopes are farmed, the steep upper slopes, which are principally Dekalb, being forested.

The Pocono red shale forms the surface capping of some of the high, rounded hills which are of still lower horizon than the ridges and hills capped with the Pocono white and yellow sandstones, Olean conglomerate, or with one overlying the other. It was seldom possible to show these hilltop areas. The largest examined contained only 40 acres. So while red shales may be traced as they appear on Leslie's geological map, deep weathering has so mixed the soil débris of the superincumbent layers of red, gray, yellow, and brown shales, white sandstone, etc., that the prevailing color of the soils is rarely red enough to constitute the Upshur soils. In many places these soils are so dovetailed with the Dekalb soils that they could be shown only by a very detailed survey—in fact more detailed than is warranted in this region.

The Upshur soils are justly regarded as being more productive than the Dekalb soils, and where they occur in fairly level, small tracts they bring good yields of the staple crops.

The loam, silt loam, clay loam (silty), and fine sandy loam are the prevailing types in this series, though the clay occurs on steep eroded areas where it is seldom farmed. Their steep position in many in-

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stances causes these soils to suffer much from erosion, and under any proper system of farm management would necessitate keeping them covered whenever possible with sod or cover crops.

Corn is not a very certain crop on account of injury from frosts. Buckwheat will average 20 bushels only with good farming, and an average yield of oats is 20 bushels. Clover is successfully grown by the few who understand liming, or who apply wood ashes, and it should be a much more important crop. Apples grow well, particularly the Twenty Ounce, King, Rhode Island Greening, Fall Pippin, and Strawberry. Baldwin has not been very successful and Bellflower has been indifferent. Apples can be grown profitably to the extent of supplying the limited local demand by selecting locations not too susceptible to frosts where satisfactory transportation can be arranged. Farms with fair improvements range in price from $20 to $40 an acre, the same as the Dekalb farms, but the average price of the soils of the series is much higher on account of the much higher percentage of soil reasonably well adapted to tillage.

Terrace and Bottom-Land Soils.

A glance at the map will illustrate, by the location of the alluvial soils with reference to the three main divisions of upland soils, corresponding sets of conditions under which the terrace and bottom-land soils have been laid down.

By far the greater part of such soils occurring in the whole area are associated with the Volusia series, because their sedimentation was made possible only by the ice sheet which during its recession dammed the water courses, thus forming ponds and long, narrow lakes. At the highest flooded levels, then, during the glacial recession considerable amounts of sedimentary soil materials were deposited, which form at present the Wheeling soils of the second terraces. Then a stage of more rapid melting and outflow was established and continued for some time, with the result that the water table was lowered not only steadily but with sufficient rapidity to prevent any noticeable sedimentation until the lowest level was reached. At this stage or at the final subsidence of the dammed waters, due to the complete melting of the glacier, the slower movement of the waters as the lower base level was reached caused the sedimentation of the present Genesee soils of the first terrace. So, from the nature of the ponding and flooding that took place during the formative period of the Volusia soils, it is not strange that at the present time a well-developed series of first and second terrace soils accompanies them and marks the halting periods of the glacial waters' subsidence. The most recently formed areas of sedimentary soils are the local occurrences of Meadow land along some of the streams and lakes, whereas local swampy areas are still in a soil formative period.

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Divorced from glacial influence, the Dekalb-Upshur country is composed of rock materials so resistant to weathering and erosion that streams have been able for the most part to cut only sawtooth valleys, along which there has been little or no opportunity for the formation of terrace or alluvial soils. On the contrary, the precipitateness of the streams has rushed all soil-forming materials downstream to the Volusia country, where the fall is not only much less, but where the ponding conditions above referred to have allowed the terraces accompanying the Volusia series not only to store up its own alluvium, but also to appropriate that which the Dekalb and Upshur series have lost. Hence, with the exception of broken terraces along the Allegheny River—a stream much larger than any crossing the Volusia region, and thus not affording a fair comparison therewith—there are no terrace soils of importance associated with the Dekalb or Upshur series. The small areas which do occur with these soil series as first bottoms have been mapped as the Huntington soils, while those along the Allegheny River are principally the Wheeling soils.

Quite different have been the conditions on the Dunkirk plain, where the lake sediment soils have been cut across by streams flowing from the Volusia plateau to the south. This mellow alluvium has offered little resistance, the streams have clean-cut banks which rarely overflow, and no terrace or bottom-land soils of consequence have been formed above the basal material, except along Elk Creek near Girard.

WHEELING SOILS.

The Wheeling or second-terrace soils occur principally in Crawford, Mercer, and Warren counties. The soils were formed by the reworking of the glacial material by the streams that issued from the glacier front, and they are more or less stratified. The soils are brown, with brown or yellowish-brown subsoils which are usually of about the same texture as the soils. These soils are well drained and productive, though in local areas they are somewhat subject to drought.

In texture the Wheeling soils range from sandy and gravelly loams to heavy loams and silt loams. Gravel beds are frequent in occurrence at varying depths below the surface. According to circumstances, these may be injurious or beneficial, the former only in accentuating the effects of drought. On some of the most productive areas of the loam member of the series the soil consists of a mellow, brown, medium loam 9 inches deep, overlying a subsoil of brown loam which is rather stiff but not heavy. This is an excellent soil, yielding 60 bushels of shelled corn, 40 to 60 bushels of oats, and 20 to 25 bushels of wheat per acre. The more sandy and porous types are less productive, but as a soil series the crop averages are good, as is shown by a

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general range in price of $60 to $100 an acre where well improved. The sandy types of the series are used to some extent for trucking and gardening with good results. Many very desirable farms are located on the Wheeling soils, improvements are well advanced, and the farmers are generally prosperous.

GENESEE SOILS.

Along many of the numerous streams in the Volusia country are alluvial first bottoms varying greatly in width and character of soil materials. The color of these soils is wide in range, but is most often a dark brown, with yellow-brown or grayish subsoils, which are not infrequently somewhat mottled. These soils have been derived from the reworked materials of the sandstone and shale uplands, augmented in much of the area by washings from the glacial soils. In texture these soils are extremely variable, ranging from sands to heavy clays, and in general no large areas of any one type of soil occur. The Genesee soils, while subject to overflow, are in many places considered sufficiently safe from loss by this source to be used for tilled crops, the fine sandy loam being well adapted to corn, potatoes, truck, and garden crops, the loam and silt loam to corn, grass, and grain. Areas more subject to overflow or not as well drained furnish excellent pasturage, and so bring a good income. Local areas are subject to more injurious washing, and so are of little value, but they are not sufficient in extent to be of consequence. Similar to the preceding in importance are swampy areas which would have been included in Meadow if larger in extent.

HUNTINGTON SOILS.

The Huntington soils occur as narrow bottom lands in the Dekalb-Upshur region, where local conditions have permitted the formation of little valley flats or slight benches along stream courses which have characteristically cut V-shaped valleys. These soils are subject to overflow from swift-flowing waters, and are variable in texture even on small areas. They often afford excellent pasturage, but only the best-drained spots can be used for tilled crops.

CLIMATE.

There are three distinct sets of weather conditions in the region surveyed, corresponding to the three broad topographic divisions previously outlined. Were the data available from a sufficient number of weather stations located on each of these divisions at representative elevations to work out with precision a comparison between them it would be most interesting, but unfortunately this involves greater detail of observations than has yet been made. The tempering influence of the lake on the climate of the adjoining plain is well

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known. A further fact has been demonstrated in that a part of this modifying influence extends for at least a little way up the escarpment slope to the south into the Volusia soil region, thus making possible an extension of the vineyard interests. But to just what extent this occurs, or may be depended upon to insure weather conditions favorable to the grape, has yet to be established; and there is a fine point just here between climatic safety and soil adaptation which requires local verification.

The controlling climatic factor in grape production is not one of mean seasonal temperature, but rather of seasonable and unseasonable frosts. To illustrate, an equalized temperature curve extends from the lake-shore belt southward far over the Volusia soils and including most all of Crawford and Mercer counties, but the length of the frost-free season is much greater along the lake shore than well up on the escarpment. And it is only for a short distance south of the escarpment that the frosts are held off long enough in the early autumn to make grape growing safe.

In the southern district, too, the advisability of setting tree fruit, particularly apples, depends in some measure upon the relative immunity from late spring frosts, while the corn crop and vegetables as well are similarly affected. These climatic problems are primarily local rather than regional in scope, as is illustrated by the frequent loss, in hollows or depressions, of fruit and other crops by late spring frosts.

Below are given weather records in so far as such are available to illustrate the conditions in the general area:

Normal monthly and annual temperature and precipitation.

Month.	Erie.		Saegerstown.		Greenville.		Skidmore.		Franklin.	
	Temperature.	Precipitation.	Temperature.	Precipitation.	Temperature.	Precipitation.	Temperature, year 1908.	Precipitation, year 1908.	Temperature.	Precipitation.
	° F.	Inches.	° F.	Inches.	° F.	Inches.	° F.	Inches.	° F.	Inches.
January	26.2	3.08	25.0	3.11	27.1	3.65	26.0	2.63	26.2	3.69
February	26.2	2.85	22.9	3.36	25.5	2.54	24.0	2.70	23.4	3.31
March	33.5	2.66	34.8	3.36	36.6	3.97	40.5	4.45	38.1	3.42
April	44.4	2.40	45.3	2.86	45.6	2.90	47.8	2.20	45.9	2.56
May	56.6	3.43	57.3	4.65	57.5	3.34	60.2	5.05	58.2	3.27
June	66.5	3.75	65.6	4.34	66.6	4.31	66.6	2.45	65.8	4.85
July	71.3	3.21	69.4	4.97	70.3	5.00	71.8	3.65	71.2	4.75
August	69.6	3.26	67.3	4.48	67.2	3.69	67.6	2.70	68.7	3.73
September	63.9	3.49	61.8	3.85	61.7	3.48	66.6	.95	63.5	3.73
October	52.9	3.80	50.5	2.98	49.3	3.42	55.4	1.60	.....	2.89
November	41.1	3.61	38.7	3.54	38.3	2.99	39.1	1.00	39.6	3.27
December	31.9	3.06	28.5	3.32	31.0	2.72	30.8	2.10	28.9	3.32
Year	48.7	38.55	47.3	44.82	48.0	42.01	49.7	31.48	.....	42.79

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Normal monthly and annual temperature and precipitation—Continued.

Month.	Warren.		St. Marys.		Emporium.		Wellsboro.	
	Temperature.	Precipitation.	Temperature.	Precipitation.	Temperature.	Precipitation.	Temperature.	Precipitation.
	°F.	Inches.	°F.	Inches.	°F.	Inches.	°F.	Inches.
January	25.2	2.90	22.8	2.79	26.1	3.19	24.6	3.09
February	22.7	2.52	20.9	2.00	25.2	2.98	25.0	2.83
March	35.1	3.07	34.4	.....	35.3	3.87	32.1	3.48
April	43.9	3.10	43.6	3.00	47.4	3.07	44.2	3.30
May	56.5	4.78	56.3	3.53	59.5	4.61	57.1	4.41
June	64.7	4.24	63.1	4.58	67.5	4.54	64.6	4.32
July	69.7	5.50	69.1	5.07	70.7	5.01	68.9	3.71
August	67.3	4.05	66.3	3.72	68.4	3.88	65.6	3.64
September	62.1	3.91	60.4	3.59	62.1	3.34	59.5	2.54
October	51.0	3.12	49.6	3.24	50.3	3.26	49.0	3.69
November	39.0	3.58	37.3	2.85	39.5	2.96	37.7	3.20
December	27.7	3.41	26.0	2.91	29.7	3.51	28.8	3.51
Year	47.1	44.18	45.8	.....	48.5	44.22	46.4	41.72

Dates of first and last killing frosts.

Year.	Erie.		Saegerstown.		Greenville.	
	Last in spring.	First in fall.	Last in spring.	First in fall.	Last in spring.	First in fall.
1901	Apr. 10	Nov. 19	May 15	Oct. 4	.....	.....
1902	Apr. 8	Nov. 8	May 29	Oct. 8	.....	.....
1903	Apr. 5	Nov. 11	Apr. 28	Sept. 20	May 8	Sept. 29
1904	Apr. 21	Sept. 22	May 12	Sept. 22	May 12	Sept. 21
1905	Apr. 22	Oct. 26	May 24	Oct. 26	May 21	Oct. 26
1906	Apr. 8	Nov. 1	May 10	Oct. 1	May 11	Oct. 11
1907	Apr. 20	Oct. 19	May 22	Oct. 9	May 21	Oct. 21
1908	Apr. 17	Nov. 13	May 5	Sept. 30	May 4	Sept. 30
Average	Apr. 14	Oct. 30	May 14	Oct. 5	May 13	Oct. 8

Year.	Skidmore.		Franklin.		Warren.	
	Last in spring.	First in fall.	Last in spring.	First in fall.	Last in spring.	First in fall.
1901	.....	.....	May 16	Oct. 4	May 16	Oct. 4
1902	.....	.....	May 29	Oct. 10	May 15	Oct. 21
1903	.....	.....	May 5	Sept. 29	May 5	Oct. 24
1904	May 28	Sept. 22	May 12	Sept. 23	May 12	Sept. 21
1905	May 24	Sept. 26	May 24	Oct. 24	May 24	Oct. 25
1906	May 8	Oct. 11	June 12	Oct. 1	May 20	Oct. 8
1907	May 22	Oct. 1	May 22	Oct. 1	May 28	Oct. 9
1908	May 3	Sept. 30	May 5	.....	May 5	Sept. 30
Average	May 17	Sept. 30	May 20	Oct. 5	May 16	Oct. 10

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Dates of first and last killing frosts—Continued.

Year.	St. Marys (1,740 feet above tide).		Emporium (1,050 feet above tide.)		Wellsboro (1,327 feet above tide).	
	Last in spring.	First in fall.	Last in spring.	First in fall.	Last in spring.	First in fall.
1901	Apr. 17	Sept. 20	May 7	Oct. 4	May 16	Oct. 4
1902	May 10	Sept. 15	May 29	Oct. 10	May 29	Sept. 6
1903	May 2	Sept. 19	Apr. 28	Sept. 29	Apr. 6	Sept. 29
1904	May 12	Sept. 22	May 12	Sept. 22	May 12	Sept. 22
1905	May 24	Sept. 27	May 21	Oct. 26	May 21	Sept. 27
1906	May 21	Oct. 1	May 21	Oct. 12	May 21	Oct. 12
1907	May 22	Oct. 2	May 22	Oct. 19	May 30	Oct. 6
1908	May 2	Sept. 30	May 4	Sept. 17	May 10	Sept. 16
Average	May 10	Sept. 25	May 15	Oct. 6	May 14	Sept. 26

It will be noticed that the favoring climatic conditions of the lake front do not furnish a mean annual temperature appreciably higher than that of various other stations within the area where vineyards are much less safe, but that the shore belt represented by the Erie records has a much longer season free from frosts than any of the other stations.

REVIEW OF THE DEVELOPMENT OF AGRICULTURE IN THE AREA.

A brief sketch of the agricultural development of the region surveyed is perhaps the shortest course to an adequate understanding of its present soil and farming conditions.

The region is divided both topographically and physiographically into three well-defined sections, the boundaries of which in this case coincide with those of the three principal divisions of soils indicated on the accompanying soil map.

The first of these corresponds to the lake plain along Lake Erie. This plain, which was formerly lake floor and has a resultant topography, extends back from 2 to 4 miles, with an average distance of about 3 miles. The surface of this region is generally level, the most marked feature being a succession of old shore lines. Of these, two or three are well defined, while others are slight and broken, local beach markings being of frequent occurrence.

Succeeding this lake plain on the south is a moderately rolling plateau. The boundary between these divisions is always definite and usually abrupt, the plateau being locally designated as "hill country." The plateau belt has an approximate width of about 19 miles near the west end, 47 miles near the center, and contracts to 32 miles toward the east end of the area. The southernmost division, which extends to the southern boundary of the area surveyed, and in most cases far beyond, is much higher in altitude than the country to

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the north; and although originally a high plateau, it has been so deeply and so sharply dissected that it is now, for the most part, very rough in surface features. On this account it is locally designated as "the mountainous country."

These three divisions are as diverse in character of soil series as in surface features. No less marked are the three systems of agricultural adaptation and development, not only as they exist now but also as they illustrate three definite stages of soil development, viz, (1) the pioneer stage, with limited farming to furnish partially the necessary food supplies to the major part of the population while engaged in removing immediately available natural resources, such as tan bark, timber, etc.; (2) the general farming stage, when the major part of the region becomes cleared and is used for growing staple farm crops, such as cereals, corn, and hay; and (3) the special farm industry stage, where some particular crop or product, or more than one, assumes a leading place in agricultural production because of peculiar adaptation to special conditions, or possibly because general farming on account of thick settlement and consequent high price of land is no longer profitable.

Of these divisions, the southern or mountainous area, which corresponds to the pioneer stage, is occupied by the Dekalb and Upshur soils, the middle or plateau region by the Volusia and Warren soils, used for general farming, and the lake plain by the Dunkirk soils, adapted to special crops.

In the southern division the early settlers—these counties were first settled in the last part of the eighteenth and the early part of the nineteenth centuries — were guided primarily in the selection of places to clear for farming by the character of the topography.

Originally a lofty plateau of sandstones and shales, a great part of this region has been dissected into a succession of deep, saw-toothed valleys, with sharp interjacent ridges. In places the old plateau level has been more uniformly resistant to the agencies of weathering, and at present occurs as isolated high plateau areas surrounded by deeply eroded gorges. These level areas were commonly chosen as locations for settlement while the forests of the whole region were being removed, and the only agriculture was the production of farm supplies for local consumption. Tan bark and lumber, together with potash and pearl ash, were the products of the country, and as the supply of these began to decline it seemed that the region would revert to forestry. The discovery, however, of petroleum oil of high quality delayed such impending tendency, and clusters of oil derricks are still a prominent feature of the regional landscape, as they bid fair to remain for some time to come.

So long as the development of these immediately available natural resources continues profitable the markets afforded by lumber camps,

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oil-district settlements, and the towns necessary for the handling of the business of these two industries will cause a limited agriculture to flourish, even though it could in no way take part in the shipment of farm products to exterior markets. This is due to two reasons—first, the soil is not suitable, and second, the rough-featured country renders transportation too costly. Crop yields, moreover, on these soils were not heavy enough to stimulate general farming to the point of competing with the soils of the second and third districts of this area or with soils of similar productivity beyond the area. Hence farming has never been developed to any considerable extent on the Dekalb soils and only in well-located areas of the Upshur soils.

In the area covered by the second division the removal of timber by the early settlers left a smoothly rolling plateau, generally adapted to farming as far as surface features were concerned, and possessed of a much more productive class of soils than the mountainous section. As a result a type of general farming developed consonant with a region of productive soils favorably located for agricultural purposes. Extensive farming—wheat, oats, and grass, with some corn—was the régime adopted, and this practice still prevails. The soils, while somewhat varied, are such as to tend in some measure to retard the development of special crops, and, besides, the results of the system followed have been good enough on well-managed farms to warrant a continuance of the system.

In the third division the Dunkirk soils were early cleared and general farming prospered. The soils were more easily tilled than the "hill lands" to the south, and animal husbandry developed rapidly. The level surface of this lake plain, moreover, made it the natural gateway for railway transportation lines between New England, New York, and Ohio and the westward States. The combination of such features as these led to a much greater, as well as more rapid, increase in population than took place in the other two divisions of the area, and as a result the prices of land rapidly advanced. This movement brought these soils directly into competition in the production of staple farm crops with soils cheaper in price and yet at least equal in average crop yields.

Fortunately for the agricultural welfare of this favored section, the soils were such as to render feasible the growing of a wide range of garden and truck crops, small fruits, etc., not only for the rapidly increasing population and local canning factories, but also for shipment to neighboring regions less fortunate in crop adaptation; and so the necessity for competing with the Volusia soils in the production of general farm crops has been largely removed.

The factor of chiefest importance, however, in the modern agricultural development of this section is its striking adaptability, on account of climatic and soil conditions combined, to the growing of

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grapes. In fact, it is this special crop that has given the lake shore agricultural distinction.

PRESENT AGRICULTURAL PRACTICES.

GENERAL AGRICULTURE.

The present agricultural practice of the area, the character of the farm products, and the general agricultural conditions are so varied that the region will be considered under three headings—the Dekalb-Upshur district, the Volusia-Warren district, and the Dunkirk district.

In the Dekalb district the character of the farm products is wide in its entire range, but the principal products may be readily grouped according to topography, marketing possibilities, and the character of the soils.

Where the topography is rough, the sources of income are the same as already described under earlier conditions—chiefly timber products and oil. Level areas beyond the limits of practicable driving distance from markets are used for a very general kind of farming and the growing of home supplies. An occasional beef, a few hogs and veal calves, a little butter, some poultry and eggs, and sometimes potatoes, are the chief sources of income, although a small farm is very often run by the family of a man who works steadily with his own horses at "teaming," the job consisting of days' work or hauling some of the forest products by contract.

Dairy produce to supply local markets and to some extent for shipment is the principal output of the level areas near such towns as Coudersport, Austin, Oil City, Franklin, Warren, and Tidioute. Near these markets garden crops are grown to some extent, and the market conditions at Oil City, at present the largest and most active market on the Dekalb soils, will indicate concisely the demand for farm crops which can be grown with profit on these soils.

Poultry and eggs, particularly the latter, could be produced in this locality at a profit. The only large commercial poultry plant in the area sells nothing locally. This plant has been established for seven years, and at the present time has between 50,000 and 60,000 ducks and ducklings, these figures representing the maximum number during the year. A branch of this plant carries 2,500 hens. All the output of dressed poultry and eggs is shipped to New York City, hence the plant should prove an incentive rather than a deterrent to an increase in the production of poultry and eggs for local markets, and of the latter for the general markets as well. The grain to support such a development, however, should be home-grown in most cases. The soils may be made to produce the necessary grain and forage crops with economy, the expense of carriage is reduced to a minimum, as the products represent a relatively high money value, and the mag-

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nitude of the venture may be made to fit the convenience of everyone with reference to investment or as complementing other lines of farm activity.

Potatoes are shipped in by the carload and in smaller lots, notwithstanding the fact that soils well adapted to their economic production are convenient to the local markets.

The opportunity for farmers to sell a high quality butter put up in prints is excellent. In the past little attention has been paid to marketing the butter in attractive form. Very often the butter has been put into tubs which do not attract the buyer, and not infrequently butter from two or three different churnings, which may represent as many weeks and much variation in quality, is all packed together in the same tub. Such butter brings the farmer only 15 cents a pound or so, as grocers can not depend on its quality. As a result many grocers refuse to handle it altogether, and buy creamery tub butter, largely from Chautauqua and Cattaraugus counties, N. Y. It does not pay farmers to produce butter low in quality; hence improvement in methods of production and making must come, as well as in bringing it to the purchaser in a form that will appeal to him. A few farmers are already doing this and sell at remunerative prices to private customers. There is opportunity for many more to do the same thing, but the demand is for strictly high-class butter packed in prints.

Garden vegetables bring a good price in the local markets until there is an oversupply, and then there is no profitable outlet. In some parts of the area not enough green vegetables are grown for local consumption. That is, the supply is sufficient only at the time of ripening from one common planting time, namely, when the ground gets in good condition in the spring. Then for a few days there may be even a glut in the local market. If a series of plantings of different varieties of vegetables, small fruits, etc., were so made as to enable the grower to furnish the hotels and private families with a sequence of the products throughout even the growing season it would be accepting with a high rate of profit the money which now goes outside the district to pay others for growing these things and the transportation companies for bringing them into the area.

Hay for the towns in the Dekalb-Upshur region is brought in largely from the Volusia region to the north, and while the Dekalb and Upshur soils can not, generally speaking, compete with the Volusia soils in the production of this crop for outside markets, the heavy loams, the clay loams, and the silt loams are well adapted to grow all the hay that can be consumed within the area cheaper than hay can be shipped in, plus the additional freight charges. In some favorable localities, where these soils are near stations, hay might

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also be grown to advantage for outside shipment. Because of danger from frosts only early maturing varieties of corn should be planted.

In a favorable year the crop of apples is enough for local demands, besides a few for shipment. In such years the local price is about 50 cents a bushel. The occurrence of unseasonable frosts, however, is the limiting factor in commercial orcharding in this region as far as the production end is concerned, the uncertainty of the crop very frequently necessitating the importation of apples, while peach growing is very hazardous. Here, then, an adverse climatic factor and either limited markets or high expense in reaching larger markets restrict the development of a fruit industry which the soils if properly handled are capable of maintaining. Some of the most successful varieties of apples on the different soil types of these series are the Northern Spy, Rhode Island Greening, Greasy Pippin, and Winter Rambo. These varieties all do well on the types of soil adapted to them.

On the Dekalb and Upshur series little attention is given to the adaptation of soils to the different crops, and the subject of suitable rotations, too, is neglected on most farms. The agricultural methods followed are on the whole adapted to present conditions only if the present undeveloped condition of the region is the ideal in view, but the fact must not be overlooked that the markets available for much of the region are not such as to furnish incentive for developing methods very much more intensive. Hence the successful farmer must be he who can in some way develop market possibilities or produce relatively high-priced material to sell in order that transportation charges shall not call for an unduly high percentage of the gross returns of the product.

The subject of farm labor in this region, while increasingly pertinent in farm management, is not more difficult than elsewhere. Of the total number of farms, a higher percentage is tilled by the owners on the Dekalb-Upshur soils—approximately 80 per cent—than on the Volusia or the Dunkirk soils. This method of land operation follows the intensity of the agricultural practice.

There are likewise the most rented farms on the Dunkirk soils, though the exact figures are not available, as there are no counties that contain only Dunkirk soils. The Volusia soils may be roughly estimated on the same basis as having 75 per cent of the farms tilled by the owners, yet Erie County, with a comparatively small proportion of Dunkirk soils, has by the 1900 census only 66.8 per cent, and from these figures the approximate conditions may be inferred.

Considering the size of farms, the Dekalb-Upshur region probably contains the largest in total area, but of improved farm land the Volusia farms contain the most acres. The average acreage of

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Dunkirk farms is not large, though there are some large estates. Here, however, the farms all consist almost entirely of improved land.

In the Volusia soil region general farming has been almost universally followed, corn, oats, wheat, and grass being the regular rotation, but with buckwheat also as an important crop wherever in the rotation it happens to be convenient. This plan of rotation is merely a development of the agriculture of the early days. Most of these crops are consumed on the farm, dairy products being the principal source of income. Potatoes and hay are the leading money crops. Most dairymen market as many hogs as needed to utilize the skimmed milk to advantage. Pork sometimes occupies a more prominent place in the list of farm products, but in most cases it depends upon and is consistent with the size of the dairy.

Dairying is most extensively carried on near the larger towns, and brings marked results in the improvement of the farm. Cheese factories and creameries have been established over the Volusia region and have given such impetus to dairying that the number of cows is steadily increasing and the quality improving. Most of these factories are cooperative in nature, the manager making the butter or cheese, marketing the product, and returning to the patrons their proportion of the net returns after deducting the cost of making and his own commission. Under such conditions both the gross and net returns from dairy products are relatively much greater than in the Dekalb-Upshur region.

The conservatism, more or less justified, which the general stability of farming as a business both engenders and fosters has been unconducive to change either in the character of farm products or in the methods of production. This is seen in the tenacity with which a crop such as hay is made the principal source of income on many farms, disregarding the land depreciation consequent upon a system of farming so unbalanced. Hay may be an excellent money crop, especially if only a moderate percentage acreage is sold annually for this purpose, and provided further that the yield per acre is kept to a high standard by efficient soil management. The yield may be kept up in many different ways, according as it may be made to fit into some definite scheme of farming. But one of the chief sources of unremunerative returns is to allow the yield to decrease until there is no possibility of profit in the crop. In these days of expensive labor and of increasing requirements to make an intensive cropping system profitable there is a strong tendency on the part of some to try to avoid as many of these difficulties of farming as possible and to keep most of the land producing hay.

There is notable lack of initiative in devising some effective system of soil cropping and manipulation and then holding the farm up to a

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high standard of production. Lack of profit with inherited methods has often been a source of discouragement rather than a spurring incentive to devise new plans to overcome unsatisfactory conditions. Encouraging examples of prosperous farmers are sufficiently frequent, moreover, not only to determine the tone of a goodly share of the region but also to serve as examples of good farming.

It is as yet only the exceptional farmer on the Volusia soils, however, who recognizes differences in the adaptation of his soils to crops. Most farms are run on an extensive plan of management. A field is left in sod as long as the hay crop is worth harvesting, and usually much longer than the crop may be termed profitable. Then it is gone over with the old established rotation, but there is usually too little manure to allow of the land being plowed as often as it should be, and so fields are often left in *Danthonia spicata*, or, as known locally, "white top," "wild oat grass," "poverty grass," "woodchuck grass," etc. Some attention is paid to the adaptation of soils to the potato crop, however, the loam being preferred for this purpose.

Little commercial fertilizer is used and no attention is given to the specific needs of the soil. Few farmers have made sufficient study of fertilizer formulas to understand the character or composition of the fertilizer used, but in buying are guided almost entirely by the recommendation of the local agent. Lime is of great benefit to most of the Volusia soils and should be more extensively used. In fact, the field is probably exceptional that would not be benefited by at least one application of lime during the course of each rotation as now practiced, and if as many green crops were plowed under as there should be for the most economical improvement of the soil, then lime should be applied more frequently to neutralize the extra acid engendered by the decay of this additional organic matter. Such treatment in conjunction with the application of all the stable manure obtainable would increase materially the productiveness of these soils.

Attention should also be called to the negligent practices which prevail on most farms in regard to saving carefully all the manure. Most of the liquids are lost in one way or another. Because of the lack of absorbents, of stable gutters, of covered manure sheds, etc., and because perhaps of the presence of a sloping surface under the stable or through the barnyard, or both, all this valuable material is successfully conducted to the nearest rivulet and stream, thus depriving the soil of a great amount of fertility which the farm has actually earned for itself. The only outlay to the farmer necessary to save a great part of this valuable material consists in constructing gutters of suitable planks as nearly water-tight as possible, or, better still, of cement, and then to put the stable cleanings on the fields daily whenever possible, preferably with a manure spreader. When daily application is

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impossible or impracticable, sufficient absorbents should be used to take up all the liquids. The manure should then be stored in a dry place under cover only until the first day arrives when a field can be made ready to receive it to advantage.

The initial expense for so fitting stables and storage shed often looks large to the farmer, and if the improvements were to last only one year it would not often be a profitable expenditure, but when considered on the basis of being used for several years, or for generations, the annual expense is very slight, and the problem as a whole is one of the vital factors in making farming on these Volusia soils far more profitable than it now is.

Artificial drainage of the Volusia silt loam and parts of the clay loam must be installed before the possibilities of these soils can be effectively developed. Laying aside technical statements of the advantages derived and scientific explanations of what takes place in the soil to bring about these benefits, the fact remains that crop yields are sufficiently increased to more than offset the expense of installing the drains. The failure of the corn crop to mature at high elevations could also be prevented many years where the crop is now lost by frosts, as the soils would dry out much earlier in the spring, and thus the growing season would be lengthened. The soils would "warm up" earlier, so that corn would sprout and grow, and the results of occasional years when the soil is so "cold" in the spring that the seed corn rots in the ground instead of sprouting would be largely avoided. With this start corn would maintain its lead over that planted on fields without artificial drainage throughout the season and ripen often enough before the autumn frosts to change corn from an uncertain crop to one sufficiently safe to warrant a great extension of its culture. And the crop would rarely be lost except in years with midsummer frosts, a factor not of sufficient importance to render the growing of early maturing varieties of corn unfeasible.

The heavy types of the Volusia soils should be plowed gradually deeper and tillage should be much more thorough; in fact, the amount of preparation tillage now given these soils should be multiplied by the figure 2 at least. Attention should also be given to plowing when both soil and subsoil are in the proper moisture condition and to harrowing before the furrows have a chance to dry out and form clods.

Considering the importance of hay as a money crop under present conditions and the marked adaptation of the Volusia loam, the Volusia silt loam, and the Volusia clay loam to its profitable production, it seems unfortunate that the methods of production involving increase in the yield and improvement in the quality of the crop are not

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adopted. It is a conservative statement of the capabilities of the Volusia soils to say that the total yield of the hay crop could and should be doubled in quantity, for it might well be increased more than that. Lime, an increased organic content of the soil, and on some soils drainage, are the three fundamental agencies required to bring this about. Shorter rotations would constitute a fourth agency in many cases. The sturdy and conscientious statement sometimes made by farmers that poverty grass (*Danthonia spicata*) is worth more to feed than timothy might have some weight did it not ignore the fact that the yield of the latter grass per acre should be three to four times as much as the present yield of the former. But the prevalence of the poverty grass is due to the great length of the period during which the land is left in sod and to the unsuitable condition of the soil at seeding time, such as the lack of drainage and poor tilth, together with an acid condition of the soil.

The Volusia soils constitute, first of all, a stock-supporting region, and under present conditions dairying is the most profitable phase of cattle farming. Sheep husbandry is secondary, but is profitable in some instances and should prove so in many more. In fact, the sheep business offers oportunities far superior to beef production.

To the extent of utilizing mares needed to do the farm work, colts could be reared with a good margin of profit, especially on farms where dairying is not emphasized or where more cows could be fed than the available labor can milk. Apple orcharding with modern methods of tillage or mulching, pruning, spraying, etc., offers a certain source of greatly increasing the farm income on the proper soils of the Volusia series.

The Volusia soils of northwest Pennsylvania are now productive or can be made productive as a rational economic procedure. In some districts neglect and unwise tillage have reduced crop yields to a point below profitable production, but even in such districts, notwithstanding the many unprosperous farmers, practically no abandoned farms were seen.

The signs of poor farming are seen both individually and in localities as above referred to, where failure to understand how to handle the soil is the fundamental difficulty, but taking the Volusia region as a whole it is reasonably prosperous, considering its present stage of agricultural development. There are enough highly successful farmers, furthermore, on these Volusia soils to serve as a demonstration lesson of what may be done by others.

The outlook, in fact, for agriculture in the general Volusia region of Pennsylvania is good. The most essential need is to bring the poorly tilled and badly managed farms up to the same point of efficiency as that already attained by the best farmers. Were this

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done, the prosperous appearance of the region would be general. The above statement of conditions does not mean that there is no longer plenty of room at the top of agricultural practice in this region for advantage to be taken not only of more specific adaptations of the different soils to crops, but also for improvement in soil management and farm practice; on the contrary, this very point needs to be emphatically brought out so that there may always be incentive toward competent and effective leadership.

On the Dunkirk soils a wide range of crops are grown and the products sold are varied in character. As already noted elsewhere, corn, oats, wheat, and grass, rotated in the order named, were the staple crops until competition with cheaper soils became keen, and in self-defense special crops were tried as an experiment. The success incident to some of these crops has demonstrated that the present prices of the Dunkirk soils are not yet too high for their profitable use in some phases of agricultural and horticultural production.

First to be considered is that part of the Dunkirk soils still used for general farming. At some distance from favorite highways and from villages such lands of good quality may be purchased for $100 an acre. Selected areas of the clay, clay loam, silt loam, loam, and gravelly loam, also some areas of a dark-brown heavy fine sandy loam, may all be made to bring profitable returns in general farming, especially where the crops are fed to milch cows that are capable of making profitable use of such feeds at market prices on the farm. Of course, a dairy farm should produce a good deal of pork or in some other way turn the skimmed milk to good account, and there are many other side products which may be grown in conjunction with dairying. The range of such crops is extensive on the Dunkirk soils and they require further mention elsewhere. Some of these are truck crops, both early and late, and small fruits whenever a farm includes some of the lighter types of the series. On farms which include only heavy soils hay may be grown profitably for market. This has been a frequent practice, but unfortunately only a part of the farmers understand, or are willing to put into consistent use, methods of cropping that will enable them to produce yields as profitable as these soils should give.

The light sandy members of the Dunkirk soils can not at their present sale price be used for general farming with profit. Little attempt is made, in fact, to do this, except on some of the rented farms, the owner of such property occasionally finding it necessary.

Garden truck, small fruits, and canning crops are the principal products of the sandy Dunkirk soils, except where grapes take precedence. The local markets use a good deal of produce of this sort, and there are ample shipping facilities both westward and eastward,

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as well as southward to Pittsburg. The surplus products are utilized by local canneries.

There are two principal combinations of crop arrangement on the Dunkirk soils; first, that of grapes with truck crops on the lighter soils, and secondly, that of grapes with general crops on farms including some soils that are too heavy for truck crops. Again, an extensive acreage of grapes requires a considerable capital, and few farmers have all their suitable grape land in vineyard. So the problem of the best secondary crops for the remainder of the farm is one of importance, as some good grape land must be used for growing crops of other kinds. In addition to the products already mentioned, many experimental departures have been made into the realm of the general production of tree fruits—apples, pears, cherries, peaches, plums, prunes, apricots, quinces, etc.

In addition to the general garden crops, the cut-flower business has assumed considerable importance, and a good start has been made in greenhouse extension. So successful has the latter been that the output is likely to increase in volume.

A considerable scope of Dunkirk soils makes up farms with sufficient attractions of natural location and improvement to cause their selection for home and residential purposes. The use of such properties is made to conform to the convenience and plans of the owner rather than to any particular adaptation the soils may chance to have for the growing of definite crops.

Labor conditions in the region surveyed are varied, and the labor hired is from different sources, but on the whole it is satisfactory. In the Dekalb-Upshur region little outside help is employed, the local supply being nearly sufficient. In the Volusia region most of the laborers are native born, but the number of foreigners is increasing. On the Dunkirk soils competent foremen are usually employed, with a great deal of day help for special crops, particularly for picking grapes. On the fruit and truck farms few laborers are kept during the winter season.

In the Dekalb-Upshur region farms are for the most part run by the owners, who reside on the farm. The holdings may be very large—many hundreds of acres—or small, but the area of tilled land is seldom large. The Volusia farms have a smaller total acreage than the Dekalb farms, but the area of tilled land on the former far exceeds that on the Dekalb farms. Many Volusia farms contain from 70 to 150 acres, but occasional ones are much larger—200 to 400 acres. The Dunkirk soils being much more intensively farmed and higher in price than the others, are in much smaller holdings, many of them including from 30 to 100 acres, though there are some far more extensive holdings, as well as smaller ones.

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Census statistics illustrate the land development of the region in an interesting way, and the table below is taken in part from the 1900 report:

Number of farms and area in improved land.

Counties.	Number of farms.		Area in farms.		Percentage of improved.
	Total.	With buildings.	Total.	Improved.	
			Acres.	*Acres.*	
Erie	5,957	5,818	459,861	286,480	62
Crawford	7,894	7,704	597,527	368,237	61
Mercer	4,956	4,905	397,952	285,812	72
Lawrence	2,639	2,567	215,969	160,313	74
Venango	3,278	3,198	277,378	166,810	60
Warren	3,238	3,163	276,562	131,545	48
Forest	587	575	58,522	21,439	36
Elk	996	974	81,084	35,040	43
Cameron	387	386	40,817	12,671	31
Potter	2,434	2,406	264,723	124,271	49
McKean	1,877	1,827	162,879	72,317	46

Of the eleven counties mapped, the average percentage of improved land in farms is 53 per cent. It is unfortunate, for the sake of comparison, that statistics for the lake-shore belt are unobtainable, but for this restricted area the improved lands may be estimated at 95 per cent. Crawford, Mercer, and Lawrence average 69 per cent, and if Erie be included, 67 per cent of improved lands, and this is representative of the Volusia and Warren soils. Forest, Elk, Cameron, and McKean average only 39 per cent of improved lands, and are illustrative of the Dekalb conditions.

In marked contrast to these figures are those of well-developed counties in the southeastern part of the State, where on the same basis Lancaster has 86 per cent of improved lands, Berks 84 per cent, and Chester 83 per cent, the Hagerstown, Chester, and Penn series of soils being largely represented.

SPECIAL INDUSTRIES.

The fact that the northern part of Erie County, Pa., not only forms an important part of the so-called "Chautauqua grape belt" along the southern shore of Lake Erie, but also that the town of North East is the greatest grape shipping point in the eastern United States, indicates the agricultural as well as the horticultural primacy of the grape as a money crop in the Lake Shore belt of the area surveyed.

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In the township of North East, with a total area of 28,672 acres, there were 5,000 acres of grapes in 1907, or about 17.5 per cent of the total area, while of the total area of Dunkirk soils within the township about 25 per cent was in vineyard, and the shipments from the two railway stations in 1908 were 518 cars, and in 1907 the product required 676 cars. While grapes are the chief fruit crop of this belt, there is also an enormous output of small fruits and large amounts of plums, prunes, cherries, pears, apples, and peaches.

Of the varieties of grapes grown in the North East belt the Concord is the only one that can be depended upon to sell readily in full carload lots in every market. As a result the Concord is the commercial variety of the whole lake belt, and corresponds in market position to the Baldwin apple in the East and to the Ben Davis in the Middle West.

A full car of Delaware, Niagara, Catawba, Worden, Brighton, Agawam, or other variety of grapes is difficult to dispose of anywhere, but mixed cars sell readily, and so a relatively small acreage is still planted with these varieties. Of these secondary varieties the Delaware and the Niagara are by far the most important, with plantings of the latter rapidly decreasing, as they no longer sell at a higher price than the Concord, and hence there is no object in planting them.

It is roughly estimated that the Concord occupies at least 80 per cent of all bearing vineyards, while more than 90 per cent of present plantings are of that variety.

During the general planting of the older extensive vineyards little attention was given to the selection of soils. Inasmuch as grapes would grow anywhere in the lake belt and were practically immune from frosts, the fact of the differences in profits which the different kinds of soil would bring was not heeded; in fact, as such adaptations had not then been demonstrated, they could not even be considered.

Accumulated experience, however, has eventually shown that some soils within this favored belt are worth much more than others for grape growing. And the fact is very noticeable to-day that the percentage of vineyards that are being allowed to "run out" is very much greater on the distinctly sandy soils than on some of the heavier types.

The ease of cultivation of the sandy soils, which led to the planting of many vineyards upon them in the early days of grape growing, is offset many times by the disadvantages attending the industry on these light soils. It costs more to fertilize; the ravages of the "rose-bug," or rose-chafer, are very much more serious, because the mellow character of the soil favors their development, and besides grape-juice factories and wineries will pay more for grapes grown on a heavier soil. This is simply because grapes grown on the heavy soils will yield

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more expressed juice per ton and of a higher sugar content than fruit grown on the sandy types of soil. This point has already become a matter of the highest importance, for it means nothing less than that the grape-juice men and the wine men will purchase from preference Concord grapes from vineyards on the heavy soils, either as a whole or those remaining after the selects have been used for basket trade, before they will take those from the light soils. Some years this makes no difference, as all the surplus grapes are needed, but in years of a glut in the market it means that the grapes from the heavy soils are sold first, even if they do not bring a higher price, and it is believed that eventually a higher price will be obtained because of their great value for the purposes to which they are to be put.

The highest quality of Concord grape is grown on the clayey soils, and the fruit will ship much better because it is more firm, but the greatest yield per acre is obtained from the loam types. Hence the soil problem of the grape grower is how to select the soil that will produce the highest quality of grape consistent with a satisfactory tonnage. As far as the Concord grape is concerned, the sands should be eliminated on the one side for reasons already stated, while soil as heavy as the Dunkirk clay is not relatively profitable because the high quality of the fruit produced does not make up for the low yield.

Under present conditions, therefore, the gravelly loam seems to be the most valuable soil for growing the commercial Concord. The clay loam is next in order, and under certain lines of treatment may equal the gravelly loam. If stable manure and green crops, especially hairy vetch, are used in sufficient amounts to keep the clay loam very mellow and friable and yet not enough to cause an excessive growth of vine, an ideal soil results because the quality of the fruit is excellent, and in this way the yield may be maintained at a satisfactory point. This is working toward high quality of product without impairing the yield, though a profitable limit is soon reached on account of the extra cost of working and the greater injury from the heaving of the vines in winter on soils that are too heavy. There is some tendency to utilize heavier soils for Concord vineyards than formerly, and it is probable that this tendency will increase—a fine sandy loam, either gravelly or not, being the lightest of the desirable soils for that variety.

The Delaware vine, being weak in habit of growth, is much more liable to serious injury from heaving at times of alternate thawing and freezing in late winter than any of the other commercial varieties, and so is not safe on soils as heavy as the average of the best Concord soils.

The Delaware should not be planted on soil heavier than a loam, and it does exceptionally well on a fine sandy loam. The Niagara is

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similar to the Delaware in soil preferment, but also succeeds on soils a little too heavy for the latter variety.

Thus while soil adaptations have been solved commercially only on broad lines, and that as a process of elimination on the part of the best growers, the fact remains that when segregated from the other factors which have to be considered in locating vineyards the soil factor is one of great commercial importance, while for any who wish to work up a special trade in select table grapes it is of the utmost concern.

The cultural methods followed in vineyards by competent growers are intensive. The vines are planted in a deep double furrow to facilitate working, which practice is also said to lessen injury from the grape root-worm. In cultivation the soil is not drawn away from the vine until late in June or very early in July, after which it is thrown toward the row. A three-gang plow is used first, and then a special form of cultivator, which is often supplied with one disk next the row to control the amount of dirt thrown and to assist in cutting out weeds between the vines. With a slow-walking team it is possible to do most of the hand hoeing with this cultivator, at least to such extent that one man can hoe out the remaining weeds by hand at a rate of several acres in a day. Many workings are profitable, say not less than eight, and even a greater number is desirable. There is almost no limit to the amount of care which it is profitable to bestow on a vineyard, while the neglected vineyard is never profitable for very long.

There is great latitude in the fertilization of the vineyard soils, and while it is commonly asserted that the grape will grow without fertilization or with very little, the best growers are fertilizing more and more each year. An application of 400 pounds per acre of a fertilizer analyzing 2 per cent nitrogen, 8 per cent phosphoric acid, and 10 per cent potash used in conjunction with a cover crop of crimson clover is an average representative treatment. Some use from 600 to 800 pounds of the same formula, while a few of the most careful growers use from 500 pounds to as much as 2,000 pounds per acre according to conditions, and in some cases stable manure is used. The Delaware grape requires high fertilization.

Grape roots are bought largely from Fredonia, N. Y., though local men sometimes grow a patch of one-fourth to one-half acre. The cost of these roots is about $20 a thousand. The roots are commonly planted 7 feet apart in rows that are 8 or 9 feet apart, though some growers plant 8½ by 6½ feet, this giving about 600 vines per acre. Still others plant the Concord 8 by 9 feet. The Delaware grape, having a much less vigorous growth of vine, is planted closer.

During the first year another crop is almost always grown between the rows of the vineyard, and some persist in inter-row cropping for

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a longer period, but the best growers never go beyond the first year, and some are now discontinuing even this practice and substituting clean tillage and cover crops.

At the end of the first year the vines are well sprawled over the ground, and the following spring, before the vine starts to grow, it is tied to a 2-wire trellis with twine, and is henceforth trained to this two-arm system. The first wire is placed about 24 inches from the ground, and the second 26 to 28 inches above the bottom one. Four canes should be put up for each vine, but some growers tie up too many canes on young vines. The Delaware vine requires high fertilization to make sufficient wood to bear a heavy crop, and is more difficult to prune satisfactorily than the Concord. So it is trained to the umbrella shape by extending an arm over the second or top wire and then tying it to the bottom wire. By this system the danger of the string breaking, as sometimes happens with the first method, is obviated. The Delaware buds are so much thicker than the Concords that there is great danger lest too many buds be left for the vine to carry, and thus overtax the vine. Spraying is now effectively carried on by all the best growers, a spray motor outfit being largely used.

A great deal of extra labor is employed at picking time, girls and women being preferred for this work. The harvest is the only time during the year when a large force is necessary, as one man with a team can take care of from 20 to 40 acres, depending upon the intensity of cultivation. The pruning is done during the winter season, and so can be done by the force required to drive the teams during the summer.

Grapes bear about one 8-pound basket per vine the third year from planting, provided good care has been given. After that 400 baskets per acre is an average yield, but a well-cared-for vineyard should give 600 baskets the fourth year, and hold to that yield for many years. The best growers not infrequently get a yield of 1,000 baskets per acre. This represents a very high profit, and is the reward of the skillful grower who does not hesitate to give an extra amount of care every year and to fertilize heavily, thus maintaining his vineyard at a high point of efficiency.

The price of grapes varies, but the price almost never gets so low that the good grower can not make more than the expenses of producing the crop. The skillful grower obtains a sufficient yield to make the business profitable even at low price. The price frequently goes below the point of profit, however, for the ordinary or careless grower, but that is not the fault of the business; it is the fault of the man.

One great advantage that the grape industry has over the growing of tree fruits is the fact that the vineyard bears annually, and another

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advantage is that it comes into bearing at about one-fourth the age of an apple orchard, and yet produces well for a long term of years.

The opportunity for the extension of grape growing on the Dunkirk soils and also on the low adjoining hills of the Volusia loam to the south is excellent for the man with skill above the average. This opportunity includes not only the growing of good yields for grape-juice factories and the ordinary wholesale trade, but also for growing and packing fancy table grapes.

Good grape land within reasonable distance of the railway station at North East is worth $150 an acre. Land ranges in price from $100 to $250 an acre, owing to location with reference to town or the lake front. It costs about $100 an acre additional to bring a vineyard to bearing age. The selling price of vineyards ranges from $200 to $500 an acre. Even at the latter price a good vineyard pays excellent profits, and while many think it more attractive to buy a good vineyard already in bearing than to plant a new one, there is good opportunity for one to grow his own vineyard from the start and thus procure an even stand of well-pruned and productive vines in the space of only four years.

Large quantities of strawberries, red and blackcap raspberries, with some blackberries, gooseberries, and currants, are grown both in the open field and also as fillers in young vineyards and in orchards. Besides supplying the local markets with these fruits, large quantities are used in local canneries and also shipped out of the area. Some growers sell their whole crop to a Pittsburg firm.

There are some good orchards of plums, prunes, cherries, pears, and apples, but these are all secondary to grape production. Of these, apples are the most important, but there is serious question whether it is advisable to plant apples extensively on the Dunkirk soils. This land is much higher in price than other soils that are just as good for apples, both in Erie county and elsewhere. They do offer an opportunity, however, for the vineyardist who dislikes to "put all his eggs in one basket" to diversify his fruit crop to some extent. The feeling is general that the apple orchard, though profitable, is less so than the vineyard, and as a result few orchards are being set out. The orchards set are mostly for the purpose of insurance against some possible failure of the grape business. Most apple orchards are of miscellaneous varieties, but the Spy and Baldwin are the leading kinds. Orchards of peaches, plums, prunes, cherries, apricots, and pears are all profitable on the different Dunkirk soils and show the wonderful diversity of this justly celebrated fruit belt.

The opportunity for profitable apple production on some of the soils of the area is good, furnishing, in fact, one of the most promising fields as an important money crop.

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One of the first problems in orchard planting in the Volusia region is to select soil adequately drained. There are in the aggregate large areas of the Volusia loam which are naturally well drained and suited to apple orcharding. There are likewise much larger areas of poorly drained soils, particularly of the silt loam and of the clay loam, which are not adapted to fruit growing at all until artificially drained. The cost of such drainage precludes their use for such purpose so long as there is enough other soil with good natural drainage. So while the Volusia loam as a type is well drained, the clay loam would need additional drainage over much of its extent and the Volusia silt loam practically throughout its entire area before either would be satisfactory for orchard planting. Some of the Warren soils would need tile draining to fit them for orchard planting, but there are many good orchard sites on these soils with good natural drainage. The Upshur soils are well drained over most of their area, while some of the Dekalb soils on account of their coarser texture are inclined to be droughty. Based upon the field work of the writer in this and other areas, the following varietal adaptations to soils of the leading varieties of apples in this region are suggested:

The Northern Spy succeeds best on medium loam underlain by heavy loam or light-clay loam. If planted on soils too sandy, good color is obtained at the expense of tree growth and quality of fruit, whereas too clayey soils produce fruit with greasy skins. The desirable soil characteristics are best supplied by heavy Volusia loam and Volusia stony loam, while well-drained areas of the Volusia clay loam and the Volusia silt loam, if kept in good mechanical condition, are also suitable. Similar soils in both the Warren and Upshur series are also well adapted to the Spy. While fairly successful on some of the Dekalb soils, the Spy is not there commercially desirable. In the Dunkirk region the loam, silt loam, and a few selected areas of the clay loam are also adapted to this variety.

The Baldwin is the second variety of importance. This apple does not color well on soils as heavy as the most clayey of the Northern Spy soils, preferring types with a higher content of sand. It is especially adapted to the lighter phases of the Volusia loam, also to the heavy fine sandy loam and to the Volusia stony loam of the textures named. The loam and fine sandy loam, also a mellow silty loam of the Upshur series, will produce good Baldwins, while the same classes of soil in the Dekalb series bring highly colored fruit, but of inferior size, unless the soil is kept in much more fertile condition than is usual with this series. Dunkirk loam and Dunkirk fine sandy loam on the lake plain are excellent for this variety. The Twenty Ounce would also do well on the Volusia loam and moderately well on the fine sandy loam; but on the more sandy soils this variety tends to be "knotty" and irregu-

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lar in shape. This latter tendency is also a characteristic of the Bellflower, which succeeds best on a rich fine sandy loam or mellow loam.

The Tompkins King is successful only under restricted conditions here as elsewhere. The weak habit of growth of this variety, its tendency to collar rot, etc., make necessary a soil which shall maintain uniform conditions of growth, a soil that can withstand within reasonable limits conditions either of drought or of excess moisture. Medium to heavy Volusia loam, Upshur loam, and Upshur silt loam best supply the soil conditions for this variety.

The Rhode Island Greening distinctly prefers a moderately heavy soil, somewhat more clayey than the Spy. A surface soil of heavy silty loam or light silty clay loam underlain by a silty clay loam excels for this variety. Such soil will retain sufficient moisture to be classed as a moist soil, yet it is not so heavy as ever to be ill drained if the surface drainage is adequate. Such soil conditions maintain a long seasonal growth under uniform conditions of moisture, and thus produce the firm yet crisp texture, the remarkable juiciness, and the high flavor for which this variety is noted when at its best. If grown on a sandy soil, the Greening lacks in varying degree fineness of grain, flavor, and juiciness, all of which are necessary factors to the high quality of this variety.

Soils of this character with good drainage are rare in this region, so the Greening has seldom been very satisfactory, and is not considered a desirable variety to plant. Well-drained areas of Volusia clay loam, silt loam, and heavy Volusia loam are the best soils of the area for this variety. Several varieties of apples which are in demand in the local markets also grow well. Some of these are the Strawberry, Fall Pippin, Maiden Blush, Greasy Pippin, and Winter Rambo.

SUMMARY.

(1) Eleven counties of northwest Pennsylvania, embracing an area of 8,112 square miles, were surveyed.

(2) The region is divided into three physiographic divisions—the lake plain, a moderately rolling plateau, and lofty uplands considerably dissected.

(3) The climatic conditions of the three physiographic sections are widely divergent for a territory so limited in extent, their equableness in the lake belt being in marked contrast to conditions in the plateau and mountainous regions.

(4) Agriculturally, the lake plain with its Dunkirk soils is highly developed, producing special crops, largely; the middle section, of Volusia and Warren soils, is devoted primarily to general farming, and the dissected uplands of Dekalb and Upshur soils are interested in general farming, lumbering, and in the production of petroleum.

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(5) To the extent of supplying limited local markets, the Dekalb-Upshur region offers good opportunities to produce supplies, and in some cases to ship products of high value. The shipment of bulky products is feasible from a small part only of this region.

(6) On the Volusia-Warren soils the opportunity for the extension of the dairy industry with some money crop in connection, such as apples or potatoes, is very promising.

(7) On the Dunkirk soils, vineyard plantings should be increased on soils properly selected, but the conservative man will grow other crops in addition, and of such there are many that may be grown to advantage—small fruits, tree fruits, canning crops, market garden stuff, dairy products, and general farm crops.

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SOIL SURVEY OF CENTER COUNTY, PENNSYLVANIA.

By CHARLES N. MOONEY, CHARLES F. SHAW, LAWRENCE A. KOLBE, HUGH H. BENNETT, and RISDEN T. ALLEN.

DESCRIPTION OF THE AREA.

Center County is situated in the center of the State of Pennsylvania, getting its name from the fact that the geographical center of the State is located within its confines. The meridian of 78° west longitude and parallel of 41° north latitude intersect within the county. It is one of the largest counties in the State, comprising an area of 715,520 acres, or 1,118 square miles. Its outline is irregular or roughly anvil-shaped, with the long point extending to the east. The

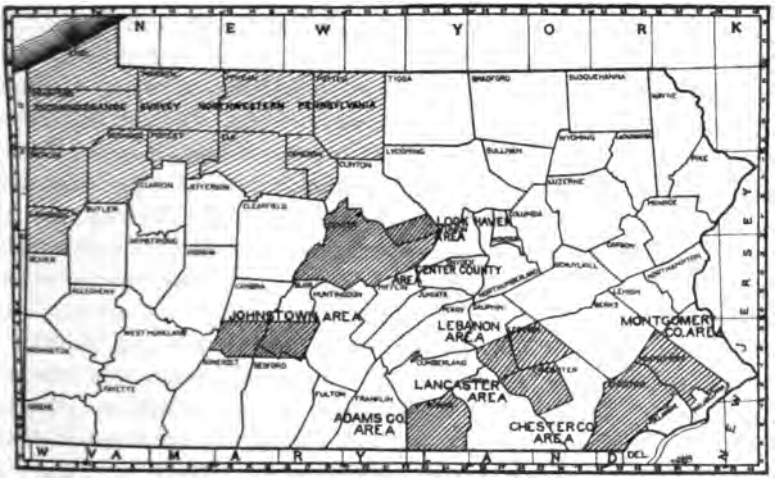

FIG. 5.—Sketch map showing location of the Center County area, Pennsylvania.

western boundary is defined by Moshannon Creek and the west branch of the Susquehanna River, the former being a tributary of the latter. Both follow a winding course. The counties surrounding Center County are Clinton, Union, Mifflin, Huntingdon, Blair, and Clearfield.

Center County lies in two grand physiographic provinces called by geologists the Allegheny Plateau and the Appalachian. In the latter province only one division is represented, that known as the Appalachian Valley division, which extends from the Appalachian Mountains on the east to the escarpment of the Allegheny and Cumberland

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plateaus on the west. These provinces and their subdivisions are separated upón marked physiographic differences, each having its characteristic forms and geological formations. The Appalachian Valley section covers three-fourths or more of the county's area; occupying all that part east of the Allegheny front or escarpment. Its topography is similar to that of the valleys of southeast Pennsylvania, the valley of Maryland, and Virginia. It consists of rolling anticlinal limestone valleys separated by long, narrow, steep, parallel synclinal mountainous ridges of sandstone. The largest of the valleys is Nittany, which has a width of several miles, the widest part being on a line northwest and southeast through State College. This valley extends across the county through the central part from southwest to northeast, and this same trend is followed by all the other valleys and mountain ridges. The Brush, Penn, and minor valleys in the eastern part of the county are tributary to Nittany. The surface configuration of these valleys is broadly rolling to somewhat hilly, with sides extending as gentle slopes up the mountains. The average elevation of the valley ridges is about 1,200 feet above sea level. The main stream courses lie 100 to 200 feet lower. The slopes as a rule are gentle. Along some of the streams gorgelike channels have been formed, but nowhere is there any great amount of surface erosion. A few miles to the west of State College and extending southward out of the county is a broad area known as the Barrens. This area is marked by a number of small knobs and irregular ridges that result in a rather complex topography. The Barrens are from 100 to 200 feet higher than the average elevation of the surrounding limestone areas, but the change in elevation from one to the other is not abrupt.

The Bald Eagle Valley is next to the Nittany in extent. It occupies the section between Bald Eagle Mountain and the Allegheny Front. However, the valley proper is limited to that part lying along Bald Eagle Creek and consists of flat bottoms, with here and there an occasional terrace. From this valley proper there is a hilly belt of country that extends to the foot of Allegheny Mountain. It is composed of shales and thin-bedded sandstone, the weathering and erosion of which has resulted in an extremely hilly topography. It consists of sharp, narrow-topped hills and irregular-shaped ridges with steep slopes, but with a smooth contour—topography that is characteristic of shale formations. From the valley proper the rise to the top of the first hills or ridges is from 100 to 300 feet and the elevation increases as the Allegheny Mountain is approached until part of it becomes really mountainous though not rugged. The elevation reached is about 1,400 feet above sea level, or 600 to 700 feet above Bald Eagle Creek. This belt is intersected every mile or two by streams that head upon the Allegheny slope and flow in narrow and comparatively straight valleys.

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The mountain ridges separating the valleys owe their presence to the resistance of the sandstones of which they are composed. All of these mountains, with the exception of Bald Eagle Mountain, which is a monocline, are synclinal. Their upper slopes are steep and in many instances precipitous, and their summits are narrow and remarkable for their even crest line. The lower slopes merging into the valleys are generally long and gentle. The crest of Bald Eagle is from 1,700 to 1,800 feet above sea level and that of Nittany Mountain about the same, with some higher points near the terminus at Lemont. Brush Mountain probably has also about the same elevation, but no data as to that fact are available. The Tussey Mountains, lying along the southeastern county boundary, rise to a height of 2,400 feet above sea level. All these mountains are composed of the Oneida and Medina gray sandstones, between which occurs the red Medina, which, being more easily weathered, has resulted in making in part of each range a double range of sharp ridges. On the sides these mountains are flanked by shale and slate formations, which form the gentle slopes from the foot of the steep or precipitous part of the ridges to the valleys below.

The western part of the county is occupied by the Allegheny Plateau. It, too, has a northeast and southwest trend. Its escarpment or front, locally called the Allegheny Mountain, when viewed from the valley appears as a steep-sided—in places precipitous—mountain ridge. Upon reaching the crest one finds a broad, dome-shaped top, and looking to the west a plateau or plainlike surface of the same general elevation with a few higher broad-topped knobs.

In reality, there is a gradual decline in elevation to the west, the surface finally dropping off rather suddenly into the valley of Moshannon Creek and the West Branch of the Susquehanna River. The elevation of the crest averages 2,200 to 2,400 feet above sea level, with some points in the southern part a few hundred feet higher. This plateau is cut by a number of streams, so that in traveling over it it appears ridgy, but these interstream areas are broad and generally quite flat. At the heads of the streams the slopes are gentle and not so stony and rough as elsewhere, but only a short distance down the slopes become steep and stony—often so stony that they may be classed as rugged. Along the lower course of Moshannon Creek and the West Branch of the Susquehanna River the slopes are quite steep. This plateau owes its origin to the Pocono sandstone and Pottsville conglomerate and to the barren and productive Coal Measures. The first two mentioned are hard, resistant rocks, the Pocono holding up the crest of the Allegheny Front.

Center County lies in the drainage basin of the Susquehanna River, and the immediate drainage of the greater part of the county is by way of creeks flowing into the West Branch of the Susquehanna River. Moshannon and Bald Eagle creeks with their tributaries are

the most important of the streams. They flow in a north to northeast direction. Moshannon Creek is fed by a number of mountain streams, among which are Cold Stream, Black Bear and Six Mile runs, and Little Moshannon Creek. Into the West Branch of the Susquehanna itself empty a number of runs from the Plateau section. Bald Eagle Creek flows northeast through the central part of the county and enters the West Branch of the Susquehanna near Lockhaven, in Clinton County. Its largest tributary on the west is Beech Creek, which for some distance forms the boundary between Center and Clinton counties. A large number of runs empty into Bald Eagle Creek from the west, draining the section from the Allegheny Front. Bald Eagle Creek, besides carrying off the water from Bald Eagle Valley, drains a large part of the Nittany Valley through its tributaries, Spring and Fishing creeks, and their affluents.

The eastern part of the county, comprising Penn, Brush, and the other smaller valleys, is drained to the east by Penn Creek and its tributaries, the former emptying into the Susquehanna River below the junction of its two branches. Half Moon Creek, in the southern part of the county, flows to the south into the Juniata River, a tributary of the Susquehanna. The drainage of these limestone valleys is unique. There are few surface streams, these being Buffalo Run and Half Moon Creek, along the Bald Eagle Mountains, Fishing Creek and Spring Creek draining Nittany Valley and the head of Penn Valley, and Penn Creek and its tributaries draining the eastern part of Penn Valley. Many square miles of the valleys have no surface streams whatever, the drainage waters sinking to the underground channels, which are evidenced by the numerous sink holes. Of the streams and runs that flow from the sandstone mountains, all except a few disappear into sink holes as soon as the limestone strata are reached. These may reappear as great springs, as, for instance, Rockspring, the head of Spruce Run, near Baileysville, and the famed Penn Cave, the source of Penn Creek. This cave is worthy of mention, as it consists of over a quarter of a mile of underground river, which can be traversed only by boat, a large sink hole affording a means of entrance.

Sinking Creek, as its name indicates, is a stream that at places along its course sinks into the rock, and appears again farther on as a surface stream. From its last "sink," about 2 miles west from Spring Mills, it exists on the surface as a small stream, dry most of the year, the main body of water following some underground channel and reappearing from beneath a massive limestone ledge as "Rising Spring" on the bank of Penn Creek at Spring Mills.

Another unique drainage system is known as Dry Hollow. This consists of a "fossil" river. At no place in the whole of this system of gorges, valleys, and tributary valleys are there any surface streams, the whole drainage being under ground. This system extends from near Rock, on Spring Creek, toward the west, spreading out as an

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extensive drainage system, some tributaries of which reach nearly to Fairbrook. The topography and land forms are strikingly like a river system, but no surface streams exist. In some cases the presence of subterranean streams can be proven by sinks or by hearing the water rushing along in the underground channel during the flood seasons.

The settlement of Center County began only a few years prior to the Revolutionary war, the first authentic settlement being made near or at what is now Milesburg, in the Bald Eagle Valley. Scattering settlers came in in the next few years, locating in the valleys in the eastern part of the county. In the decade from 1790 considerable numbers came to the county and from that time on the population increased steadily. The settlers came largely from the eastern part of the State, and were for the most part "Pennsylvania Dutch," Scotch-Irish, and Germans. Some of the earlier pioneers came from Europe direct. The earlier settlers came to occupy the land and engage in farming, while in later years others were attracted by the mineral resources.

Center County, according to the census of 1900, had a population of 42,894. The valleys are thickly settled; the mountainous parts, except where mines are located, are scarcely settled at all. In fact, large areas, as on the Allegheny Mountain or Plateau, are wild lands and unoccupied except for hunters and lumbermen's camps, the former only occupied during the hunting season.

Bellefonte, the county seat, is the largest town, with about 5,000 population. Philipsburg, on Moshannon Creek, is next, with about 4,000. It is the center of an important mining section in Center and Clearfield counties. State College is the largest of the smaller places, and is the site of the State College of Agriculture. Other towns in the county, having populations between 500 and 1,000, are Howard, Milesburg, Unionville, Port Matilda, Sandy Ridge, Snow Shoe, Millheim, and Center Hall, and besides these are numbers of small villages. In the agricultural sections of the county, mainly the valleys, the present population is still largely that descended from the original settlers, but in the mining sections a large part of the population is foreign, representing a number of European countries.

The transportation facilities of Center County are fairly good, a number of railroads passing through the county and affording communication with the main trunk lines reaching the large cities in the State and elsewhere. The Pennsylvania Railroad has a number of branch lines connecting with their main trunk lines in all directions. The Bald Eagle Valley branch follows the Bald Eagle Valley, connecting Tyrone and Lock Haven, both on main trunk lines. The Lewisburg and Tyrone division extends from Bellefonte east to Lewisburg, on the main line, in Union County. The Tyrone and Clearfield branch from Tyrone climbs over the mountain to Philips-

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burg and passes through the mining section in that vicinity, and on into Clearfield County. The Snow Shoe branch from the Bald Eagle Valley line taps the coal field at Snow Shoe. The New York Central Railroad is represented by the Beech Creek Division, which also affords an outlet to the Snow Shoe and Philipsburg mines. The Central Railroad of Pennsylvania runs through the northern part of the Nittany Valley from Bellefonte to Mill Hall, in Clinton County, and the Bellefonte Central Railroad between Bellefonte and State College. From Philipsburg an electric line extends into Clearfield County to Winburne and Morrisdale, near which places are located large coal mines. The county roads reach all points in the county and are kept in good repair. Many of them are stone pikes, some having been the pikes of early days, still kept in use and repair. On some of these tolls are now collected.

The products of the farm meet with a good demand in the larger towns and in the mining sections. With the good railroad facilities the markets in the larger cities are within comparatively easy reach.

The schools are numerous and good. Besides the high schools in the towns, the State College of Agriculture is located at State College, as also is the State Experiment Station. In the valleys the farmers have the advantage of rural telephone lines and the rural free delivery of mail reaches most of the settled parts of the county.

CLIMATE.

The appended tables, compiled from the records of the Weather Bureau station at State College, show the mean monthly, annual, and seasonal temperatures and precipitation, together with the absolute maximum and minimum temperatures for each month, and the rainfall during the years of greatest and least precipitation. The dates of the last killing frost in spring and first killing frost in fall at State College and also at Lock Haven are given. State College is located in a broad, rolling valley, and the figures represent no doubt the average climatic conditions obtaining in similar places throughout the county. There being, however, considerable differences in elevations and topography, it would seem that there are many local conditions to which the figures may not apply. Certain it is that there is some difference in temperature and probably also in precipitation between the Allegheny Plateau and the valleys, on account of the higher elevation of the former, and in fact the growing season is much shorter, frosts occurring later in the spring and earlier in the fall on the plateau. This season (1908) a light killing frost occurred in the latter part of August.

The winters are quite severe, the temperature falling as low as 20° below zero, and there is a heavy fall of snow generally throughout the winter both in the valleys and on the mountains.

The summers are cool, the summer mean being 69° F. The absolute maximum is 96° F. The extreme range in temperature is 116°.

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As in all temperate latitudes sudden changes of temperature are common.

In the valleys the growing season is of sufficient duration to mature all crops, but at the higher altitudes the season is too short for corn.

The rainfall is ample and appears to be well distributed. However, droughts are expected in the late summer and early fall.

Normal monthly, seasonal, and annual temperature and precipitation at State College.

Month.	Temperature.			Precipitation.			
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year.	Total amount for the wettest year.	Snow, average depth.
	°F.	°F.	°F.	Inches.	Inches.	Inches.	Inches.
December	31	64	− 4	3.0	2.8	4.1	.....
January	27	65	−17	2.8	4.2	4.1	.....
February	26	69	−20	2.8	0.2	5.3	.....
Winter	28	.....	.....	8.6	7.2	13.5	.....
March	35	69	− 6	3.4	1.0	4.1	.....
April	48	88	17	2.9	2.2	1.5	.....
May	59	93	27	4.5	2.2	1.9	.....
Spring	47	.....	.....	10.8	5.4	7.5	.....
June	68	95	30	4.2	6.7	4.2	.....
July	71	96	41	3.8	3.1	5.6	.....
August	69	96	30	4.0	3.7	5.4	.....
Summer	69	.....	.....	12.0	13.5	15.2	.....
September	63	93	30	2.8	1.8	2.2	.....
October	50	88	20	3.0	1.0	4.4	.....
November	40	72	9	3.0	1.7	3.0	.....
Fall	51	.....	.....	8.8	4.5	9.6	.....
Year	49	96	−20	40.2	30.6	45.8	.....

Dates of first and last killing frosts.

Year.	State College.		Lock Haven.	
	Last in spring.	First in fall.	Last in spring.	First in fall.
1899	Apr. 17	Sept. 30	Apr. 17	Oct. 1
1900	May 10	Sept. 19	May 6	Oct. 20
1901	Apr. 12	Sept. 20	Apr. 17	Oct. 25
1902	May 29	Oct. 10	May 29	Oct. 22
1903	Apr. 27	Oct. 13	Apr. 5	Oct. 26
1904	May 12	Sept. 21	Apr. 4	Oct. 7
1906	May 10	Oct. 8	Apr. 24	Oct. 12
Average	May 4	Sept. 30	Apr. 23	Oct. 16

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AGRICULTURE.

The early settlers in this part of Pennsylvania grew wheat, corn, rye, potatoes, hemp, flax, and the grasses. Wheat and corn were their principal crops, but rye soon became of even more importance, as it could be changed into a product—distilled spirits—of less bulk for transporation. With the development of the iron industries the demand for agricultural products increased and there was also created a pressing need for better transportation facilities. This was first met by the building of turnpike roads, a most important factor in the early development of the county. Their building began soon after 1800 and continued for the next fifty years. The most important of these roads was the plank road constructed between Milesburg and Tyrone in 1849, which connected at Tyrone with the great road between Harrisburg and Pittsburg, a main artery of travel between the east and the west. Three years prior to the building of the plank road to Tyrone, or in 1846, a canal was completed between Bellefonte and Lock Haven, a distance of 25 miles. Up to this time the pig iron made in the county had to be transported on the backs of horses, a slow and expensive process. The canal continued important until damaged by freshet in 1865.

Railroad building was agitated as early as 1834, when the Bald Eagle Valley Railroad was incorporated, but construction was not begun until a quarter of a century later. The first railroad to be built was the Bellefonte and Snow Shoe Railroad, which was completed in 1859 and in operation that year. Bituminous coal had been discovered in the vicinity of Snow Shoe soon after 1800 and it was to get out this coal that the railroad was built; it was also designed to be used in getting out the timber from the top of the Allegheny Mountains. The rich mineral and timber resources soon led to the construction of other lines.

Keeping pace with these several advances in transportation and with the exploitation of the mineral deposits, agriculture made steady and marked progress. Rye, which had become the most important crop before good transportation facilities were available and which even as late as 1840 was four times as important as wheat, decreased in acreage and by 1850 the ratio between the two grains had been reversed. In that year the production of wheat was 433,612 bushels and of rye 109,051 bushels. The next census shows a decline in wheat and some increase in rye, but this may have been a seasonal fluctuation. During this decade there was a marked increase in the production of corn, oats, and barley. In 1870 the wheat crop slightly exceeded that of 1850, and in fact there has not been much change in wheat production since 1850 except in 1860, the variations reported being probably due to seasonal conditions. The average

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annual production is around 400,000 bushels, taking the data of the census years. That the acreage in this cereal is practically stationary is shown by the data returned by the census for 1880, 1890, and 1900, the figures being 37,310, 31,008, and 36,716 acres, respectively. On the contrary, the growing of rye, at least for grain, has practically ceased, the census of 1900 giving the acreage as 1,828 acres, and the production as 18,350 bushels. Corn has been a leading crop of the county since an early date. It led rye in 1840 by nearly 100,000 bushels with a production of 204,122 bushels, though in 1850 it was considerably exceeded by the production of wheat. In 1870 it reached its highest reported yield of slightly over 1,000,000 bushels. Since that time there has been a slight falling off in production, though the acreage has varied but slightly in the past three decades. It occupies an acreage of 27,664 acres, or 10,000 acres less than that of wheat. The wheat crop is sold from the farms, but the corn is principally fed to live stock.

Oats and barley were grown to some extent before 1840, and the acreage of each has increased since that time. Barley is of lesser importance. In 1899 there were 2,057 acres in this cereal, yielding 47,340 bushels. The increase in acreage and production of oats has been continuous since 1840. In 1899 this crop stood third among the cereals in area occupied, with an acreage of 20,223 acres and a production of 625,340 bushels, and having increased 100 per cent since 1879. Oats have gained in favor in the last few years, owing to high prices and the fact that the crop is more certain than wheat on certain lands.

Buckwheat was also a crop grown before 1840. The census of that year reported 6,919 bushels. The production gradually increased, reaching a maximum in 1880, when 32,688 bushels were harvested from 1,858 acres. Since that time there has been a decline and the acreage in 1899 was only 953 acres.

Potatoes have long been one of the staple crops of the county, and the acreage devoted to this crop has also increased gradually from year to year. In 1899 there were 2,478 acres under this crop, yielding 240,447 bushels.

The hay crop has been important from practically the beginning. The acreage cut for hay in the last three decades has been about the same as that given to wheat. The average yield per acre has slightly exceeded 1 ton. In 1889 there were about 35,000 acres cut for hay, of which about 4,000 acres were clover. Besides this there has always been a considerable area devoted to more or less permanent pasture.

Live-stock raising received attention from the first. The early assessment records show that nearly every family had one or more cows and many of them teams of horses or oxen. Oxen were used

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quite generally for draft animals. Hogs were also kept by every family. About 1840 great interest was taken in the improvement of live stock, and some improved breeds, especially of horses and cattle, were introduced. The census of 1900 reported 297,564 acres in farms, or not quite one-half the area of Center County. Of the area in farms about two-thirds is reported as improved. A large part of the county is occupied by mountainous ridges and the high Allegheny Plateau, which is unsuited for agricultural use. On the former there is practically no cultivated land at all, while on the plateau the area is wild lands, mostly uncleared. A comparatively small part is cultivated, but the agriculture is of very little importance, the elevation and short season being unfavorable. The chief value of such lands lies in the forest products and in coal mines. There is, however, a comparatively large area included in the fertile limestone and shale valleys of the county. The farming operations are carried on upon such lands and their natural productiveness is such that Center County ranks high among the other counties of the State in agricultural production.

The average size of the farms is 127.2 acres. There are many fine farms much larger than this in all parts of the county. The indications point to a fairly prosperous condition of the farming class. The climate and soils are adapted to the production of the cereals and grasses, and this, with the large amount of wild lands affording more or less pasture, makes cattle grazing and dairying profitable. The farmers therefore follow general farming, in which cereals and grasses form the cultivated products, supplemented by dairying and cattle raising. Under this system on practically every farm all the cereal crops are produced at present. In order of importance as to acreage these crops are wheat, corn, oats, barley, rye, and buckwheat. In acreage the tame grasses cut for hay are second to that of wheat. Of the cultivated grasses timothy is the most extensively grown. Clover finds a place on most farms. Some potatoes are grown on every farm and every place has its vegetable garden, which plays an important part in the economy of the farm. The limestone soils ordinarily produce large crops, and the owners of the lands are as a rule most prosperous. The surplus of the small grains is sold from the farm and hay is also sold to some extent; but the corn crop is as a rule fed on the farm either in the form of grain and fodder or as ensilage.

Small and tree fruits are grown on most farms, there being no general effort to produce the former on a commercial scale. An exception is the production in the vicinity of Philipsburg of a few strawberries for the local market. There are a few apple orchards of commercial size in the county; also some peach orchards, but peach growing is being discontinued on account of the uncertainty of crop

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and a consequent lack of profit. Some trucking is done, particularly in the Half Moon Valley. The growers make regular trips each week across the mountain by wagon, selling their varied products of garden, farm, and poultry yard in Philipsburg and the other mining towns in the western part of the county and in Clearfield County. A few have succeeded in truck growing in the vicinity of Philipsburg.

Live stock is an important factor on every farm; cattle and horses lead, but some attention is given to the raising of hogs and sheep. Both dairy and beef cattle are produced. The wild mountain lands afford good grazing for beef cattle. The elevations being high, flies are not troublesome; there is plenty of good water and feed, and the cattle thrive. Some large areas are under fence, but for the most part the land is open, the cattle running at large. They are hunted up by the farmer in the fall and returned to the stall for finishing for market. No particular preference is shown in breeds of cattle grown for beef. They are mostly common grades. In the limestone valleys the farmers raise horses suitable for heavy farm work and for draft purposes in the cities. These are mainly of the Percheron breed. Jersey and Holstein breeds are common on the dairy farms. The product of the dairy is chiefly butter made on the farm and this is sold on the local market, especially in the nearby mining towns. Some cheese is made, but the product is not important. Very little milk is shipped from the county. While dairying is practiced generally, there are no very large dairies in the county, each farmer keeping what cows he can conveniently pasture, feed, and tend. The value of all live stock on farms, as given by the Census of 1900, is $1,258,764.

The limestone soils, as well as being the strongest and most productive, are recognized as best adapted to general farming. Besides producing the largest crops of the small grains and corn, they give the best results with grass, both for hay and for grazing.

The red shale or Upshur soils in the Bald Eagle Valley and in the small areas between the mountain ridges and the Colyer silt loam are considered next to the limestone soils in productiveness. They will produce the same crops as the limestone soils, and give yields above the average. In addition these red shale soils are considered especially adapted to fruit, particularly apples, though pears, plums, and cherries do well. The apple trees grow thriftily and bear good crops of fruit of good color and fine flavor.

The Dekalb soils are not nearly so productive as the soils already mentioned. The shale type is droughty and is best suited to small grains, which mature before the summer droughts are likely to occur. Corn, which must go through the season, does not make a good yield. Being a well-drained soil it affords early pasturage, but during the summer the grass becomes short. In wet years it is found that oats

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are a much more certain crop on the shale soils than wheat, the latter being more or less winterkilled. The clay loam, being a heavy soil, is recognized as best suited to grasses for hay and pasturage. The Dekalb loam, however, is a fairly productive soil and the general crops make good yields upon it. The Dekalb silt loam is a fairly good soil type, but its occurrence on the top of the Allegheny Plateau, where the season is short, does not permit of a wide range of crops. Corn does not mature as a rule. The best use of the type is for hay and pasturage, though it also is recognized as a good potato soil. The loose sandy and stony types of the plateau are not in demand, not being productive soils. Their best use is without doubt for forestry. The small extent of the bottom land soils makes them of relatively little importance, though where drained they make very large yields of corn and hay. They also make excellent pastures.

A crop rotation is practiced universally over the country on all soils, and is followed with very little variation. This consists of corn, wheat, oats, and grass, the latter consisting of timothy and clover, both cut for hay two seasons and then pastured for a year or two. Barnyard manure is applied to the corn crop. With the wheat an application of commercial fertilizer, usually a phosphatic mixture, is made. Lime is also used and is always found beneficial. It is said to be necessary, particularly on the Dekalb and Upshur soils, in order to get a stand of clover. Lime is of great value also on the limestone soils. Many farmers burn the lime they use in their fields. Farmers in the Bald Eagle Valley, where liming is general, haul the limestone over Bald Eagle Mountain from the Nittany Valley, obtaining the stone at a cost of 10 cents a load where they quarry it themselves. It is hauled to the farm, where there is plenty of wood, and coal can be obtained cheaply by hauling from the mines. The lime costs less in this way. Some, however, prefer buying the lime outright.

The application of lime to the soils has given very good results, but the methods used could be improved. The lime should be applied regularly in the rotations, at periods of from four to eight years and in amounts varying from 1,500 to 2,000 pounds. It has been the custom in the past to apply lime in enormous quantities, about once in fifteen to twenty-five years, or whenever the lack of lime was evidenced by the diminishing crop yields. The more regular applications in the smaller amounts, if used in connection with manures or fertilizers, would insure the maintenance of the crop yields and the elimination of any unfavorable effect on some crops that might occur when the very large amounts are applied.

The use of commercial fertilizers to supplement barnyard manure is general. The total outlay for commercial fertilizer in 1899, according to the census, was $26,200. Clover is grown not only for the forage

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it produces but for its beneficial effect upon the soils. In general the latest improved cultural methods are followed, with the use of all kinds of improved machinery for special purposes. The land is given thorough preparation and the after-cultivation is good. The plowing is deep and on the heavier soils three horses are used. Disk, spring-tooth, and smoothing harrows are on nearly every farm, and the use of the roller is also common. Improved harvesting machinery is used. The hay crop is handled largely by machinery.

The census figures show that only 56.3 per cent, or a little over one-half, of the farms are operated by the owners. The share basis of rental is the most common, though cash rent is paid in some cases. Some farms are operated by hired labor. Labor is scarce and commands high wages. The mines make considerable demand for labor, though it is supplied largely by foreign elements.

Farm values vary considerably over the county. The rough mountainous lands have very little value for agriculture. Lands in the coal-mining sections, though not of high value for agriculture, are leased for very long terms for about $25 an acre, but for the full possession this land brings from $75 to $100 an acre.

The valley soils bring of course the highest prices, the limestone lands ranging from $40 to $60 an acre, with practically none on the market. The hilly shaly soils bring from $10 to $25 an acre, while the desirable bottom lands are held very high.

In general the farm practices of Center County are good and the farmers are in a fairly prosperous condition. In certain matters there is room for improvement. In dairying especially the profits could be greatly increased by improving the herds and by adopting some of the more recent plans of dairy management. The milk output can be increased by a more general use of soiling crops, to be fed when the pastures are dry, and by adding ensilage to the winter feed.

Another opportunity for increasing the net income of the farms is found in the manurial practices. With greater care of the barnyard manure and the more frequent use of green manuring crops, many of the farmers could save at least a part of the money now expended for commercial fertilizers. These mixtures are valuable, and, in special cases, absolutely essential to the best results, but they should not be depended upon in the case of farms where a little more forethought and well-directed effort can give satisfactory substitutes with practically no cash outlay. In this connection the clover crop should receive more attention and its acreage be increased, for this is one of the best ways to improve the soil naturally.

On the limestone soils the introduction of another valuable legume, alfalfa, would materially increase the value of the forage crops. It has been shown on the experiment station farms at State College and in some scattered fields in the Nittany and Penn valleys that

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the crop can be successfully grown and large yields obtained. In preparing for this crop the land should be well limed and thoroughly tilled in order to provide a suitable seed bed and enable the crop to get through the first season. Both spring and fall seedings have proved successful. Alfalfa does best on the heavier limestone soils, the Hagerstown clay loam, clay, and silt loam being best adapted to its production. Yields of from 3 to 6 tons per acre per year have been obtained.

With the good markets afforded by the near-by mining towns, which are usually in sections where little farming is done, more attention could well be devoted to trucking where soils suitable for the purpose occur. Even if light truck crops are not grown, the heavier truck and vegetable crops would repay the effort. The potato acreage could easily be extended. The markets could stand an increased supply of tomatoes and sweet corn, both of which do well in this county. Cabbage and cauliflower should be produced in greater quantities. The dealers now obtain supplies from outside the county. The small fruits, particularly berries of different kinds, could be more widely grown with profit. All the tree fruits should also receive more attention, the plantings extended, and cultural methods adopted to produce fruit of good quality.

Finally, the advisability of preserving and even extending the forests can not be emphasized too strongly. There is much land that is suited to no other purpose.

SOILS.

The soils of Center County fall into five general divisions—the limestone valley soils, the related Barrens soils, the red shale foothill soils, the soils of the narrow synclinal mountain ridges and of the Allegheny Plateau, and the recent alluvium along the streams. Except in the case of the last named, the soils are closely related to the underlying geological formations, and with that one exception all are residual in character.

The most important, though not the most extensive, soil series of the county is the Hagerstown, derived from the solution and weathering of the Trenton limestone. These soils are composed of the more or less insoluble residue left in the rock during the process of solution and removal of the magnesian limestone of the Trenton period. They are rarely very deep, usually resting on the hard, unweathered rock at less than 15 feet from the surface. They have excellent drainage through the cracks and subterranean channels in the soluble limestone, yet because of the heavy nature of their subsoil are quite retentive of water.

There are five types of this series mapped in this area—clay, clay loam, silt loam, loam, and stony loam. Of these the clay loam is

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most extensive, while the clay, silt loam, and stony loam are nowhere extensively developed. They occupy the rolling valley land and the types are rather closely related to the topography of the region—clay occurring on steep knobs and knolls, where erosion has been most active, the clay loam on the gentler slopes, and the silt loam in small local depressions in the other types, where the finer particles, washed from the higher soils, have tended to accumulate. The loam occurs on the crests of the broader anticlinal ridges where the base of the Trenton is approached and the soil derived from the more impure and cherty limestone.

These soils are very similar to the Hagerstown series of soils found in the limestone valleys of southeastern Pennsylvania, in Maryland, Virginia, Kentucky, and Tennessee. They occur wholly in the southern half—south of the Bald Eagle Mountains—in the Nittany, Penn, Brush, and smaller extensions of these valleys.

Closely related geologically to the limestone soils occur the soils of the Barrens, occupying eroded crests of the great anticlinal folds in Nittany and Penn valleys. These soils are generally sandy in character and are derived from a mixture of sandstones, clays, and some limestones, whose exact geological horizon has never been definitely established. They occupy irregular and much eroded ridges, are excessively drained, and have little water-holding capacity, and have been classified in the Morrison series, first mapped in the Johnstown, Pa., area.

The soils of the shale foothills, derived from the red shale rocks of the Clinton formation, probably rank next to the limestone soils in agricultural value. These soils occupy the Allegheny escarpment and the adjacent foothills. Owing to their topographic position, they are subject to rapid surface drainage and are liable to erosion. These soils have been classified in the Upshur series and correlated with soils mapped in other parts of Pennsylvania, in West Virginia, and other parts of the Appalachian uplift. A phase of the Upshur soils is found in the narrow synclinal valleys on the crests of the synclinal mountain ranges in the southern part of the county. Here the soil is derived from the weathering of the Medina red sandstone, and the soil is sandier in character than the soil from the shale formation. There were two types mapped in this series, the Upshur loam and Upshur stony loam.

The soils of the Allegheny Plateau and the synclinal mountain ridges fall in the Dekalb series. There are nine types developed in the county, ranging from a sand to a clay loam. Generally speaking, the heavier members of the series are found on the slopes of mountain ridges, while the lighter soils are developed on the plateau. The soils vary much in agricultural value, depending on the derivation and topography, as well as on the character of the soils themselves. The

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soils on the mountain ranges are derived from the shale and sandstone rocks which lie above the Trenton limestone—the Utica and Hudson River shales, the Oneida and Medina sandstones. On the plateau they are derived from the Oriskany, Catskill, and Pocono sandstones and Pottsville conglomerate, from the Chemung and Hamilton shales, and from the rocks of the Barren and lower productive Coal Measures.

A related soil type—the Colyer silt loam—derived from the black carbonaceous shale which lies between the Trenton limestones and the Utica shales, has a rolling topography, excellent drainage, and a very high agricultural value. It is most extensively developed in Georges and Penn valleys, and is ranked as second to the Hagerstown clay loam in agricultural value.

The soils of the stream valleys, or the recent alluvium, are not extensively developed anywhere in Center County and are not of much agricultural importance. There are five of these bottom soils, falling into two series—Huntington and Moshannon. They exist as narrow, irregular bands along the larger streams of the area and generally are variable in texture. In most cases they are composed of the material from the adjoining soil and rock formation, and vary as these vary, though along the Moshannon and Bald Eagle creeks, where the development is most extensive, fairly uniform soil conditions exist.

Small areas of Meadow, some Swamp, and a large area of Rough stony land were also mapped in the county. These are all described at length in the following text.

The appended table gives the names and areas of the several types of soil developed in Center County:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Rough stony land	248,064	34.7	Meadow	5,248	0.7
Dekalb stony sand	70,016	9.8	Colyer silt loam	4,928	.7
Hagerstown clay loam	65,920	9.2	Moshannon loam	3,968	.5
Dekalb silt loam	46,656	6.5	Moshannon fine sandy loam	3,584	.5
Dekalb stony loam	45,312	6.3	Hagerstown silt loam	3,136	.4
Upshur stony loam	39,808	5.5	Swamp	2,176	.3
Dekalb stony silt loam	27,712	3.9	Morrison stony loam	2,048	.3
Dekalb shale loam	25,536	3.6	Upshur loam	1,984	.3
Hagerstown loam	21,760	3.0	Morrison clay loam	1,280	.2
Dekalb sand	19,200	2.7	Dekalb fine sandy loam	896	.1
Morrison sandy loam	17,792	2.5	Morrison sand	640	.1
Dekalb clay loam	15,488	2.2	Huntington sandy loam	512	.1
Dekalb loam	11,904	1.7	Madeland	448	.1
Hagerstown stony loam	9,344	1.3	Huntington gravelly loam	384	.1
Huntington clay loam	7,424	1.0			
Hagerstown clay	6,592	.9	Total	715,520	.....
Morrison loam	5,760	.8			

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HAGERSTOWN CLAY LOAM.

The surface soil of the Hagerstown clay loam consists of from 6 to 8 inches of a yellowish-brown or reddish-brown silt loam to silty clay loam. The subsoil is composed of a lighter colored silty clay loam which grades into a reddish-yellow heavy clay loam or clay at 18 to 20 inches.

The type as a whole shows considerable variation. The surface soil may range locally from a light silt loam to a heavy clay loam, depending largely on the topographic position. Surface wash, moving the finer particles to the local depressions, may make the surface soil much deeper and very silty. The same erosive action, carrying away the surface soil, leaves the soil much shallower at the tops of the ridges and "breaks" or changes of the slope. In some places where the erosion has been most active the soil approaches a clay in texture. These changes are common throughout the type, especially in those areas where the topography is more variable.

The subsoil also varies, though within narrow limits. The stratum of lighter colored material may be absent, the soil resting on a heavy reddish clay loam or clay at depths of 6 to 10 inches. Both soil and subsoil are friable and are very easily tilled. Even when plowed in a wet condition they do not clod readily, but may be easily reduced to an excellent condition of tilth.

The type for the most part is free from stones, though in places it becomes quite stony, as much as 15 per cent of rock fragment being present. Limestone ledge outcrops are numerous in some areas, being especially noticeable along the Brush Valley and Spring Mills pikes east of Center Hall. Northwest of State College some of the type contains considerable chert, being known as "flint land." Most of this "flint land," however, is Hagerstown loam. Wherever the ledges or stones are especially numerous they have been indicated on the map by suitable symbols.

This type is extensively developed throughout the valley regions. One area, varying in width from 2 to 6 miles, extends from Baileysville, on the southwestern county line, to Woodward, in Penn Valley, 35 miles northeast. This body forks between State College and Lemont, one large arm extending through the eastern part of Nittany Valley, being most extensively developed east of Bellefonte. The southern arm, forking again at Penn Cave, reaches in a long, narrow band thoughout the length of Brush Valley.

This type occupies all topographic positions in the valleys, occurring on ridges, slopes, in level stretches, and in the steep hilly districts. For the most part, it occurs as moderately rolling country, becoming hilly near some of the larger streams, notably along Spring Creek.

The Hagerstown clay loam is very well drained. Most of the rainfall passes directly through the soil mass into the subterranean chan-

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nels and thence off to the regional drainage systems. There is little surface wash in evidence and surface run-off is at a minimum. The character of the underground drainage has already been discussed. The type is marked by a large number of sink holes into which the small amount of surface "run-off" disappears.

In common with the other limestone soils, the type is composed of the insoluble residue derived through the weathering and solution of the underlying rock. The mode of formation is evidenced in the fact that though the rock contains more than 70 per cent of calcium and magnesium carbonates, the soils are usually deficient in lime. These minerals are soluble and have been dissolved and carried away during the process of soil formation. It is estimated that it has taken more than 75 feet of rock to supply material to form one foot of soil.

These valleys were originally heavily forested with oak, hickory, and other hardwoods and pine. The forests have long been cleared away and much of the land has been farmed for over one hundred years.

The general farm crops are grown, the rotation usually followed being corn, oats, wheat, and grass. The yields are good. Corn yields from 70 to 80 bushels per acre, wheat 18 to 20 bushels, oats 20 to 30 bushels, and hay from 1 to 1½ tons. The hay is generally about half-and-half clover and timothy the first year, and principally timothy the second year, the clover dying out unless the land has been well limed.

In most cases the land has been very well handled since first clearing, and the yields have not decreased. The liberal use of lime is shown to be beneficial, especially when used with barnyard manure. Commercial fertilizers rich in phosphoric acid give excellent results also.

Land of this type of soil is valued at from $40 to $60 an acre, averaging about $50.

The following table gives the results of mechanical analyses of fine-earth samples of the soil and subsoil of the Hagerstown clay loam:

Mechanical analyses of Hagerstown clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
17074	Soil	0.6	1.5	0.9	2.0	6.4	58.8	29.9
17075	Subsoil	.2	.7	2.0	15.8	11.2	35.6	33.7

HAGERSTOWN LOAM.

The surface soil of the Hagerstown loam consists of 8 to 10 inches of brown or yellowish-brown loam, in places containing a high percentage of silt. From 10 to 20 inches the subsoil consists of a yellow-

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ish brown or light-yellow heavy silty loam or silty clay loam which grades to heavy red clay within the 36-inch section. In some areas the lighter colored subsoil is not present, the surface soil resting on the clay at depths varying from 10 to 15 inches.

The soil is loose and friable and is very easily worked. Generally it contains from 10 to 25 per cent of small chert or limestone fragments and in some regions, notably on the ridges south of Fillmore and south of Center Hall, is known as "flint land." These stonier phases are not as productive as the areas which contain little or no chert.

The type occurs throughout the limestone valleys, but is most extensively developed in three large bodies, one southwest of State College, another south of Fillmore, and the third south of Center Hall, between that place and Center Hill. In each of these regions the type occupies the crests of anticlinal folds of the underlying rocks. The soil occupies gently rolling upland regions in the broad valleys, though in a few cases the topography becomes quite hilly.

Like the clay loam, this type is formed by the disintegration and solution of the dolomitic limestones of the valleys. It occurs where these rocks are more impure and contain larger quantities of silica, and other insoluble rock materials. Occurring mostly on the crests of the anticlines this type has been subjected to a longer period of weathering than has the clay loam, and is even more deficient in lime than that type.

The drainage is excellent, being largely subterranean. This type, even more than the Hagerstown clay loam, is marked by numerous sink holes. In some regions they are numerous enough to be a distinct feature of the topography. Usually around the edges of these holes erosion has removed the surface material, and the resulting soil is quite heavy; where the sink has not fully developed the interior consists of much deeper surface soil, loose and friable. Ledges are not uncommon on this type, but are not as numerous as in the clay loam. The usual farm crops of the region—corn, oats, wheat, and grass—are grown. The yields are much lower than on the clay loam. Corn gives from 60 to 70 bushels, oats 15 to 20, wheat 12 to 15 bushels, and hay about 1 ton. The reason for these lower yields is not apparent and with more careful fertilization this soil should produce as well as the clay loam.

The soil is deficient in lime and often low in organic matter. Lime and barnyard or green manure give marked results. Complete fertilizers containing relatively large proportions of phosphoric acid are very beneficial.

On account of the lack of good water supplies the number of stock kept on this type is much less than the land would support. Most of the farms depend on cisterns for their water supply. Wells have to be sunk to the depth of 100 to 300 feet.

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With more stock, making more manure, and the liberal use of lime, these soils could be made very productive.

The land is valued at $20 to $50 an acre, depending largely on water supply and proximity to railroads or towns.

The following table gives the results of mechanical analyses of fine-earth samples of the soil and subsoil of this type:

Mechanical analyses of Hagerstown loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
16824	Soil	1.3	3.4	2.9	5.7	11.2	55.6	19.0
16825	Subsoil	.7	1.9	1.3	3.9	13.6	39.4	39.7

HAGERSTOWN SILT LOAM.

The surface soil of the Hagerstown silt loam consists of from 10 to 12 inches of a dark-yellow or brown silt loam. The subsoil to a depth of about 24 inches is a slightly lighter brown to yellow silt loam or very silty clay loam. From 24 to 36 inches it grades into a reddish-yellow to red silty clay loam or clay. The soil is a deep, soft, and friable silt loam, very easily tilled. It is smooth and fine and rarely contains any stone fragments.

The silt loam is not an extensive type and is found in no large bodies. It usually occurs as small irregular areas scattered throughout the loam and clay loam areas, and in many cases the bodies were not extensive enough to show on the map. The largest areas occur south of State College and west of Pine Grove Mills.

Topographically the soil is made up of local depressed areas and more extensive level upland areas. The most common occurrence is in local depressions, where the slow surface erosion of the surrounding types has served to increase the depth of the fine, silty surface soil. The drainage is usually very good, though the soil does occupy depressions. The water passes through the subsoil to the underground channels and thence escapes into the regional drainage systems.

The soil was formed originally by the solution of the limestone rocks, but is mainly the result of gradual accumulation of the fine material removed from the more elevated regions by the surface "run-off," which flowing to these depressed areas and sinking to the underground channels, has year by year added to the depth of fine material until this deep silt loam has resulted.

The crops grown are those common to the other types of the region. Yields are rather higher than on the clay loam. Corn will yield from 70 to 90 bushels, wheat 18 to 25, oats 20 to 30, and grass from 1½ to 2 tons per acre.

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Like the clay loam and loam, this type is benefited by lime and by phosphatic fertilizers. The need for barnyard manure and organic matter is not as marked as on the two former types.

The following table gives the results of the mechanical analyses of the soil and subsoil of the Hagerstown silt loam:

Mechanical analyses of Hagerstown silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
17156	Soil	0.1	0.6	0.6	1.0	3.4	68.9	25.3
17157	Subsoil	.5	1.0	.6	1.4	3.4	69.8	23.3

HAGERSTOWN CLAY.

The Hagerstown clay consists of from 2 to 6 inches of a dark-red or reddish-brown heavy silty clay loam, resting on a subsoil of stiff red clay. In a few places the immediate surface material is a light silt loam or loam about 4 inches deep resting on the typical subsoil.

Although the type is stiff and has a high clay content, it has a tendency on drying to break up into a loose and friable condition. The subsoil, too, shows some indication of jointing, and the water readily seeps through it. The type, though heavy, is not hard to till.

The soil is characterized by numerous ledge outcrops, and in most areas the bed rock lies within 3 feet of the surface. In a few areas loose stones are numerous. This is true of the area near Spring Mills and of much of the type in Brush Valley. Where stones and ledges are numerous symbols are used in the map to indicate their occurrence.

The soil occupies hills and ridges in the limestone valleys, being developed most extensively on the hills south of Lemont; near Houserville; in smaller areas near Pleasant Gap, and in a considerable area near Spring Mills and east of Penn Cave in Brush Valley.

Owing to its topographic position the soil has excellent surface drainage. Most of its drainage is through the underground channels, common to all these limestone soils.

The soil is formed by the disintegration and solution of the limestone rocks and represents that portion of the soil mass adjacent to the parent rock. There is no "rotten" or partly changed rock between the soil and rock, the change being abrupt from the clay soil to the hard limestone. This is characteristic of all limestone soils. Near the ledge outcrops in all the other Hagerstown types the clay is apt to be developed, but rarely in sufficiently large areas to be mapped.

The soil is cropped in the usual manner, giving good yields of corn, oats, and wheat, and excellent yields of hay. One field of alfalfa noted was giving excellent results.

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The type is deficient in lime and organic matter. The addition of these not only increases the fertility but improves the physical condition, making the soil more loose and friable, which aids materially in its cultivation.

The following table gives the average results of mechanical analyses of fine-earth samples of the Hagerstown clay:

Mechanical analyses of Hagerstown clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
17070, 20063.....	Soil.....	0.3	2.2	1.7	5.1	4.4	45.7	40.3
17071, 20064.....	Subsoil.....	.3	1.7	1.3	7.8	7.3	38.8	42.4

HAGERSTOWN STONY LOAM.

The Hagerstown stony loam consists of from 6 to 8 inches of a brown silty loam, resting on a subsoil of heavy red clay. The soil and subsoil contain from 20 to 40 per cent of limestone fragments and the bed rock is usually within 3 feet of the surface. The texture of the surface soil and the character of the stone content vary considerably. In some areas this rock, instead of consisting mainly of loose fragments, is formed by numerous ledge outcrops. In most cases such areas have been mapped with the type in which they occur and marked on the map by symbols. In other areas where the soil is derived from an impure limestone the soil and subsoil contain large amounts of irregular angular chert fragments ranging in size from gravel to stones several inches in diameter. In these regions the surface soil is quite variable, ranging from a light loam, through silt and clay loam, to clay. The subsoil is invariably clay, but is much deeper, bed rock being rarely within 3 feet of the surface. The area along Dry Hollow, about 2 miles southeast of Fillmore, is characterized by the occurrence of this higher proportion of chert fragments, in some cases approaching 70 per cent of the soil mass.

The Hagerstown stony loam is scattered throughout the limestone areas, usually in small, irregular bodies. The most extensive occurrences are in the Dry Hollow region, along Spring Creek canyon, and in smaller areas east of Bellefonte and Linden Hall.

In topography the stony loam is generally hilly, occurring on steep slopes and hillsides, though some level areas are encountered. The drainage is good. The type is usually in forest, but where cleared it is either farmed to corn, oats, wheat, and grass, or is in pasture. By far the larger part, however, is covered with forests of oak and hickory, with some pine and hemlock.

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Because of its topographic position and the difficulty of tilling such stony land, it is preferable to utilize land of this character in the growing of forest products.

The following table gives the results of mechanical analyses of fine-earth samples of the soil and subsoil of the Hagerstown stony loam:

Mechanical analyses of Hagerstown stony loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
17158	Soil	2.0	1.4	0.8	2.5	2.2	70.4	20.4
17159	Subsoil	1.2	1.4	.6	3.0	2.1	59.1	33.2

COLYER SILT LOAM.

The surface soil of the Colyer silt loam consists of 8 to 10 inches of silt loam, yellow or yellowish-brown in color and of loose, friable texture. The subsoil is a heavy, yellow, very silty clay loam which at depths of from 24 to 40 inches rests on soft, black carbonaceous shale. The soil has a tendency to bake somewhat after rains, but is easily worked up by use of the cultivator or harrow. The type is locally known as "soapstone land" and is considered a very good soil.

The Colyer silt loam occurs in small areas along the mountain slopes, wherever outcrops of the black shale are not covered by overwash material, but is most extensively developed in Georges Valley and in the "Loop" near Colyer. Two considerable areas occur southeast of Spring Mills and another large area north of Woodward.

Throughout its extent the soil is very uniform. It is formed by the weathering of the soft carbonaceous shales that lie between the limestone rocks and the thin-bedded shales giving the Dekalb shale loam. It occupies rounded hills and rolling areas on the synclinal folds, beyond the areas of the Dekalb shale loam, these soils being very closely related to the geological formations.

Surface drainage is very thorough, and during dry seasons crops sometimes suffer from lack of moisture. The land is farmed to the general crops of the region, with very good results. Corn yields from 60 to 100 bushels, averaging about 70 bushels per acre, oats from 20 to 25 bushels, wheat 15 to 18 bushels, hay 1 ton to 1½ tons, and potatoes from 75 to 125 bushels. As in case of the limestone soils already described, applications of lime give good results on this soil, and the use of lime and barnyard manure is very beneficial.

Land of this type of soil is considered but little lower in agricultural value than the Hagerstown clay loam, and is held at prices ranging from $40 to $60 an acre.

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The following table gives the results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Colyer silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
17090	Soil	0.0	0.5	0.5	0.9	0.5	73.1	24.4
17091	Subsoil	.0	.1	.4	1.0	1.0	60.7	37.1

MORRISON SANDY LOAM.

The surface soil of the Morrison sandy loam consists of 8 to 12 inches of fine to medium yellowish-brown, heavy sand or light sandy loam. The subsoil is a yellow or reddish-yellow, sticky, sandy loam, grading to a reddish clay at 36 inches. In the more loamy areas the surface soil is sticky when wet. Both soil and subsoil contain considerable sandstone fragments and certain parts of the areas where the stone content is high have been indicated on the map by symbols. In the area between Stormstown, Scotia, and Fairbrook the stones are very numerous, almost sufficient to make a stony sandy loam.

Soil of this description is found in the area known as the Barrens, in the western part of the Nittany Valley, and on the sand ridge near Bellefonte. The type really constitutes the Barrens region, a name which is decidedly misleading, as the region is not barren, but supports heavy forests. This soil occupies ridges and rolling to hilly areas and is very well drained. The subsoil is porous, and while some water can be found at 30 to 60 feet, wells must be driven much deeper, 300 to 600 feet, in order to obtain a satisfactory supply.

The soil is derived from weathered sandstones and quartzites. The rocks and soil contain large amounts of iron ore, and several "banks," or surface workings, are being operated. The bank at Scotia is the largest and has been in operation for over twenty-five years.

The soil supports a native growth of chestnut, oak, yellow pine, and some white pine. The last named formerly was much more abundant, but its place has been taken by the less valuable woods. A dense undergrowth of ground oak, sweet fern, blueberry, and other shrubs occurs.

But little of the type is cleared or tilled, most of it being in forest. It is held by lumber or mining companies in tracts of 1,000 to 5,000 acres, and by them leased to lumbermen who cut and clear the timber. The land then is usually allowed to lie idle until another crop of trees is ready for harvest. If the difficulty of lack of water could be overcome, it is believed this soil would be valuable for truck and

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garden crops and for berries and small fruits. Careful manuring would have to be practiced, and the soil being leachy light applications frequently applied would give best results.

The following table gives the results of the mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Morrison sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
16826	Soil	0.6	9.0	19.6	39.5	5.9	17.1	7.6
16827	Subsoil	.9	6.5	13.7	33.4	5.5	15.2	24.8

MORRISON SAND.

The surface soil of the Morrison sand consists of 6 to 10 inches of yellow or yellowish-brown fine loamy sand or sandy loam, resting on a subsoil of yellow or reddish-yellow sand or fine sand which in places is somewhat sticky.

The soil occurs in small areas through the Morrison sandy loam regions, the greatest development being between Scotia, Altro, and Krumrine. The type occupies gently rolling areas and is very well drained.

It supports a native growth very similar to that of the sandy loam, and like that type is largely covered with forest. Where timber has been removed and no valuable iron ore exists, this type and the sandy loam can be had at prices ranging from $2.50 to $10 an acre.

Both types lack organic matter, and good crops could not be obtained without generous applications of manures and fertilizers.

The following table gives the average results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Morrison sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
17160, 19115	Soil	0.2	13.5	29.0	34.6	3.4	12.0	7.2
17161, 19116	Subsoil	.4	11.2	24.4	37.4	4.9	12.5	9.1

MORRISON STONY LOAM.

The Morrison stony loam consists of a heavy reddish-yellow sandy loam or loamy sand resting on a reddish-yellow heavy sandy clay loam to a sandy clay extending to a depth of 36 inches or more. Both soil and subsoil contain large quantities of iron-cemented sandstones of varying size. In some cases, on the highest ridges and near the iron mines, the stones are so numerous that the type approaches

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Rough stony land in character. The topography is sharply rolling to hilly, with steep slopes, and if cleared the soil would be subject to severe erosion.

The Morrison stony loam is derived from the sandstones found in the Barrens region, and is very well drained. Practically none of it is cleared. It is low in agricultural value, but supports a good growth of chestnut, pine, and oak, which are being cut for mine timbers and for pulp wood.

The following table gives the results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Morrison stony loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
16984	Soil	4.3	6.4	4.3	17.1	4.1	44.0	19.6
16985	Subsoil	3.5	7.0	3.8	12.6	4.3	44.2	24.3

MORRISON LOAM.

The Morrison loam consists of 8 to 10 inches of a rather sandy heavy loam of a yellow or brownish-yellow color, underlain by a subsoil of reddish-yellow clay loam to clay. In places both soil and subsoil contain considerable quantities of sandstone fragments, but the proportion of such coarser material is not sufficient to interfere with cultivation.

Small areas of this kind of soil are found in the Barrens region, the largest area occurring just east of Scotia. The topography is generally rolling, and the drainage conditions good. The soil is derived from the sandy rocks of the Barrens. Where cleared it gives good yields of the staple crops. In its native state it supports a growth of chestnut, pine, and oak, and where cultivated and planted to orchards it has given good results with apples and cherries. It is probably well adapted to the production of berries and bush fruits, as well as to truck and garden crops.

The land where cleared ranges in value from $35 to $50 an acre.

MORRISON CLAY LOAM.

The Morrison clay loam consists of from 6 to 8 inches of brown or yellowish-brown silty clay loam, resting on a red-brown or reddish-yellow friable clay or clay loam subsoil.

The type occupies rolling areas in the Barrens and along the line between the Barrens and the limestone soils. It is derived largely from the sandstone materials, with possibly some admixture of the residue from limestone near the boundaries of the type. In some cases the stone content is rather high.

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At present the areas of this soil are largely timber or stump land. It will support good growths of chestnut, pine, and oak. Very little of the type is cleared and almost none of it farmed.

DEKALB CLAY LOAM.

The surface soil of the Dekalb clay loam, to a depth of 6 or 8 inches, varies from a heavy silt loam to silty clay loam, the latter texture being the more general. The color changes from drab or brownish on the immediate surface to pale yellow beneath. Where very dry the surface soil becomes light drab or gray. The first few inches of the subsoil is composed of a pale-yellow heavy silty clay loam which generally grades with depth into heavy plastic silty clay, usually yellow somewhat mottled with red and white or drab and brown. The mottling is the result of poor drainage, the subsoil being so close and impervious that water does not pass readily through it. The subsoil is generally moist and has a smooth, soapy feel, a characteristic found to some extent in the soil. Upon drying large cracks form in both the surface soil and, in exposures, in the subsoil.

At depths ranging from 2 to 6 feet the soil mass rests upon shale rock. Frequently, especially on the slopes of the shale hills in the Bald Eagle Valley, small weathered shale fragments occur upon the surface and in the soil and subsoil. On the mountain slopes, in addition to shale fragments, are found some subangular sandstone fragments and bowlders, both on the surface and in the soil mass. These stones are of the talus from the upper slopes of sandstone. Where these stones are of sufficient quantity to interfere materially with cultivation the areas have been shown in the map as Dekalb stony loam.

The largest development of the type is found on the gentle slopes of the shale hills in the Bald Eagle Valley. The other areas occur as narrow strips on the lower slopes of the mountain ridges, as for instance on Bald Eagle, Nittany, Brush, Tussey, and other mountains. The surface of these areas is moderately sloping, yet owing to the impervious subsoil the drainage is usually poor. That the type is more subject to erosion than the Dekalb loam is shown by the more frequent occurrence of gullies. There is thus considerable surface run-off, despite which the moisture conditions are not the best.

This type of soil is for the most part of residual origin, being derived from a number of slate and shale formations. In the Bald Eagle Valley, at the foot of shale hills, it is derived from the Hamilton and Genesee shales, which are clayey in character and Devonian in age. These areas are also modified by materials washing down from the slopes of the adjoining shale hills. On the north flank of Bald Eagle Mountain the Clinton shale formation has formed this soil, while on the south flank and on the slopes of the other mountain ridges it owes its origin to the weathering in situ of the Utica and

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Hudson slates and shales. Strata of these shale formations on the mountain slopes are comparatively thin, so that the resulting bands of the derived soil type are narrow. They are limited further by the talus from the steeper upper slopes of sandstone which rolls down over the areas and covers their upper margins to a greater or less depth, changing their character completely.

On the slopes of the mountains the Dekalb clay loam usually marks the upper limit of cleared land, the stony loam and Rough stony land above it being timbered. The type formerly supported a fair growth of chestnut and other hardwoods and pine. At present it is mostly devoted to pasture. On account of its generally wet condition on the mountain slopes, but little of it is cultivated and the yields obtained are low. Probably the best use for this soil is as pasture or mowing land. Care should be taken to get a good seeding and to maintain it by the use of top dressings of fertilizers and the reseeding of thin places. There is a deficiency of lime in the soil and the seeding will be greatly benefited by using this salt liberally, preferably when preparing the land. In the Bald Eagle Valley the areas of this soil are considered fairly good farming land and are all cleared and under cultivation. Being naturally a cold, wet soil, its best use is for the cereals and grasses. On farms in these areas both barnyard manure and commercial fertilizers are used, and these are supplemented by applications of lime. With such thorough fertilization fairly good crops are grown, and the soil as compared to the contiguous hill farms is held in higher esteem.

The following table gives the average results of mechanical analyses of fine-earth samples of the soil and subsoil of this type:

Mechanical analyses of Dekalb clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
17068, 20053, 20055	Soil.....	0.5	2.6	2.5	5.4	4.5	55.6	29.1
17069, 20054, 20056	Subsoil.....	1.4	2.7	1.7	4.3	5.6	44.6	39.9

DEKALB SILT LOAM.

The surface soil of the Dekalb silt loam, to an average depth of 6 inches, is a light, friable silt loam, gray to light brown in color on the immediate surface, changing to pale yellowish beneath and passing into the subsoil without any distinct line of demarcation. The subsoil consists of a pale-yellowish silt loam slightly deeper in tone than the soil, occasionally becoming heavier with depth and generally somewhat close and compact. It, however, contains a considerable proportion of the finer grades of sand which tend to make it friable. Often the sand content in the surface soil is sufficient to give a gritty

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feel, and in places the type might be classed as a silty fine sandy loam. Fragments of sandy shale and of shaly sandstone are found on the surface and in the soil mass in quantities varying from a few scattered pieces to a relatively high percentage. In some areas the shale content is so high as to make the soil almost a shale loam. The underlying shaly rocks are often found at less than 36 inches below the surface, though on the whole they occur at a greater depth.

The Dekalb silt loam is found only in the western part of the county upon the Allegheny Plateau. It occurs in a number of areas somewhat separated from each other. The principal areas lie in the vicinity of Philipsburg and Snow Shoe, the latter being quite extensive and covering that section known as the Snow Shoe coal basin. Another area is at the head of Little Moshannon Creek in what is called a subbasin of the Snow Shoe. These areas are developed on the top of the plateau, largely on stream divides, yet not confined entirely to this position.

The surface is rolling and smooth, with some quite steep slopes near some of the streams. The drainage as a rule is excellent.

The Dekalb silt loam is residual in origin, being derived through weathering from the shales and fine-grained sandstones of Carboniferous age. The formation is correlated with the lower productive Coal Measures in which there are a number of included bituminous coal veins. The texture of the shale rock varies from clayey to gritty or sandy. The sandstone beds are thin and the rock fine grained. In past geologic time this formation was covered by another formation known as the unproductive or Barren Measures. Removal of these upper beds in part has exposed the productive measures and given rise to the type of soil here described.

Under much of the area of this type mining operations have been carried on extensively and so much material has been removed that large areas have caved in and are now in a condition unsuited for cultivation. The greater part of the Dekalb silt loam is cleared. Originally it was covered with a heavy growth of timber, in fact, the heaviest on the Dekalb series of soils. In the vicinity of Philipsburg this soil is under cultivation and gives fair yields of the general farm crops. It has also been utilized here for market gardening, especially in the production of strawberries and the heavy truck crops, such as cabbage, cauliflower, and potatoes. The elevation is a little high for tomatoes. The strawberries are of excellent quality and give good yields. Peaches do quite well, the Elberta being best adapted to this soil and elevation. The Crawfords are said to be too tender. Between Snow Shoe and Pine Glen the land is quite generally cleared and farmed, several good farms being seen. Cereals, hay, and potatoes are the principal crops. Of the cereals oats do the best. Timothy and clover do exceptionally well, giving an average yield of

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1 ton or more per acre. Where manures and fertilizers are applied much larger yields are obtained. Potatoes are of good quality and yield an average of more than 100 bushels per acre.

For some years past heavy losses have been sustained from the potato rot and this has reduced the profits and tended to discourage growers. Much of the potato seed is obtained from Maine. The varieties most commonly planted are the Green Mountain, Snow, and Norcross. The Sir Walter Raleigh is also a favorite variety.

Being well adapted to the grasses for hay and pasturage, the Dekalb silt loam is desirable for dairying and stock raising. Where good markets are convenient the former would prove more profitable.

Improvement of the areas of this kind of soil can best be accomplished by turning under green manuring crops in addition to applications of barnyard manure. With such treatment the land can be made much more productive. Lime is always beneficial, but should not be applied immediately preceding the potato crop.

Because of the presence of coal veins, or their probable occurrence, this land has a higher value than would be warranted on a basis of its agricultural worth. Where sold in fee simple it brings $100 an acre. Without mineral rights it brings $25 an acre.

The following table gives the average results of mechanical analyses of fine-earth samples of the soil and subsoil of the Dekalb silt loam.

Mechanical analyses of Dekalb silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
17540, 20045	Soil	1.8	4.2	2.1	7.2	9.3	56.2	18.9
17541, 20046	Subsoil	2.0	5.2	2.3	8.4	9.5	48.9	23.5

DEKALB STONY SILT LOAM.

The surface soil of the Dekalb stony silt loam to a depth of 6 inches consists of light-brown to pale-yellowish heavy silt loam. The subsoil consists of a pale-yellow heavy silt loam changing with depth into a plastic silty clay loam or clay. In some places, as on the lower parts of slopes, the subsoil is often mottled yellow and drab, the yellow color predominating. Generally on the top and upper slopes of the ridges it is difficult to get the soil auger deeper than 2 feet on account of the great amount of broken stone. There is, however, some interstitial soil material down to the solid rock which lies at no great depth below the surface. These underlying rocks consist of thick-bedded shale and thin-bedded sandstone, the strata in the latter case ranging from one-half inch to 3 or 4 inches only. The quantity of rock fragments in the soil varies greatly. Along the boundary between the type and the Dekalb shale loam there is a greater pro-

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portion of shale, and the two types blend so that the line separating them had to be arbitrarily drawn. Back from the boundary the stones are more numerous and larger, the quantity being sufficient to interfere with cultivation. These stones are removed from the fields and used in building fences.

The rock fragments in the soil have an important influence on the moisture conditions, assisting drainage when there is an excess of water, on the one hand, and preventing too rapid evaporation on the other. Aside from the presence of stones and the hilly character of the surface, the Dekalb stony silt loam is fairly easy to cultivate. Areas of Dekalb stony silt loam occur as a continuous belt from 1 to 2 miles wide in the Bald Eagle Valley adjacent to the Dekalb shale loam areas. The topography consists of high rounded hills and irregular shaped ridges, with steep slopes. These hills are much higher than those covered by the shale loam and some of the country is rather mountainous in character. The slopes are generally quite steep and erosion is more or less active, shallow gullies being formed. Some small streams originate in this belt, but the larger streams have cut through it from the foot of the Allegheny Mountains.

The soil is residual, being derived from interbedded shale and sandstone. To the resistance of the latter to weathering is due the higher elevation of this type as compared with the shale loam. The rocks belong to the Chemung formation of the Devonian era. A large part of this land is occupied by forests of pine, oak, and chestnut, with hemlock in the ravines. In some places, however, considerable areas are cleared and farmed, and though the slopes are steep and difficult to cultivate, the yields of the general farm crops are fair. Corn does better than on the adjoining Dekalb shale loam. The yields of buckwheat are also larger. Of the small grains oats are most important. Clover does exceptionally well, the land being limed once in 6 to 10 years. Crop rotation is followed, the succession usually being corn, wheat, oats, and grass. A few apples, said to be of fair quality, are produced, and it is probable that the soil would make desirable orchard land.

Farms composed in whole or mainly of the Dekalb stony silt loam bring from $15 to $25 an acre.

Average results of mechanical analyses of fine-earth samples of the soil and subsoil are given in the following table:

Mechanical analyses of Dekalb stony silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
20047, 20049	Soil	1.9	3.8	2.0	5.6	14.1	51.7	20.8
20048, 20050	Subsoil	4.3	5.6	2.0	7.3	10.6	48.4	21.7

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DEKALB SHALE LOAM.

The surface soil of the Dekalb shale loam consists of from 6 to 10 inches of a friable yellow-brown silt loam, rather heavy, but so filled with small shale fragments as to be very loose and easily tilled. The subsoil consists of a heavy loam or silt loam grading into a heavy clay loam of a yellow or grayish-yellow color. It is rare that the soil section extends more than 24 inches in depth, broken shale fragments being so numerous below this as to constitute almost a rock condition. The surface soil contains from 30 to 60 per cent of shale fragments of very small size, varying from one-eighth to one-half inch in thickness and from one-fourth to 1 inch in length. The shale fragments are locally known as "gravel," and the type is known as "gravel land." In some sections the type is known as "shoepeg" land, on account of the shape and size of the shale particles. The subsoil contains 50 per cent or more of shale fragments, in fact in most cases is simply a mass of broken shale rock. The underlying shales usually lie at a steep angle and are readily disintegrated by the agencies of weathering.

In the shale belt in the Bald Eagle Valley, where the Dekalb shale loam is known as "slate" or "shale" land, the type departs somewhat from the foregoing description. The color of the soil is lighter, a pale-yellowish color, and the texture is possibly a little heavier, though this may be due to the smaller quantity of shale fragments present in the soil. The subsoil here becomes somewhat heavier with depth and is often plastic. The character of the shale formation differs from that of the Nittany and other valleys in the eastern part of the county. The rocks do not, as a rule, break up into such small fragments, and toward the Allegheny Mountains the blocks become thicker and the texture more gritty.

The most important development of the Dekalb shale loam occurs in the Bald Eagle Valley, where the soil forms a continuous belt from one-half mile to 1½ miles wide, extending the entire length of the valley north of Bald Eagle Creek.

In the Nittany and other valleys in the eastern part of the county the soil is found in narrow bands along the lower slopes of the mountains. Here it is most extensively developed northwest of Penn Cave, on a continuation of the Brush Mountain syncline; near Colyer and around Egg Hill, on the extension of the Egg Hill synclines. In these latter-named localities the soil is derived from the thin-bedded, hard shales of the Utica and Hudson River formations and the larger areas exist where the overlying sandstone material has been eroded away and the shales exposed. Topographically, the soil occupies rounded spurs along the mountain sides, or rounded steep-sided hills, where it exists in large bodies. On the shoulders of the ridges on each side of the numerous gaps, where there is not so much overwash from the

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higher sandstone areas, small irregular areas of this type are also found. These are noticeable from a considerable distance, as they are usually cleared, while the adjoining stony loam or rough stony land is forested.

In the Bald Eagle Valley the Dekalb shale loam is derived from shale rocks of a more recent geologic time, the Devonian. There are a number of formations, among them the Hamilton, the Genesee, and the Nunda or Portage. These are clay shales with interbedded gritty shales and thin-bedded sandstones. Toward the Allegheny Front the strata become thicker and harder. The topography consists of rounded hills and irregular-shaped ridges, with smooth steep slopes and narrow V-shaped stream valleys. Near Bald Eagle Creek the shale beds were softer, and this has resulted in a low range of hills with an elevation of about 100 feet, or possibly a little more, above the main valley floor. Back of this range the hills and ridges gradually become much more prominent, the rock formations becoming harder and more resistant to weathering.

Drainage in the Dekalb shale loam is thorough and rapid. In some cases the surface "run-off" is swift and considerable damage is caused by erosion.

The native vegetation was largely chestnut, oak, hickory, pine, and hemlock, and some very good stands of timber are still left.

On account of the shallow depth to rock the soil is apt to be droughty, and does not give high yields. Potatoes do well, however, and are of very good quality. One hundred to 150 bushels per acre represents the range of yields. In the eastern valleys grass does poorly, as do the grain crops, but in the Bald Eagle Valley buckwheat and oats are successfully produced. Here clover gives satisfactory growths on limed fields. The soil as a whole is not well adapted to corn, though this crop is included in the rotation. Some apples of fair quality are grown, but there are no commercial orchards. The soil responds readily to applications of manure and lime, but on account of its leachy nature small applications made frequently are preferable to large applications. Considerable care must be used in order to prevent erosion and loss of the valuable surface soil.

Farms of the Dekalb shale loam probably have an average value of $15 to $25 an acre.

The average results of mechanical analyses of fine-earth samples of the soil and subsoil from the different localities are given below:

Mechanical analyses of Dekalb shale loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
17080, 20059, 20061.	Soil.....	3.9	8.5	2.1	2.6	1.7	58.7	22.6
17081, 20060, 20062.	Subsoil.....	4.8	9.2	2.9	3.3	2.5	49.5	27.7

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DEKALB LOAM.

The surface soil of the Dekalb loam consists of about 10 inches of friable loam, yellow brown when wet and yellowish to grayish in color when dry. The subsoil is a yellowish to reddish yellow heavy silt loam grading through clay loam to clay at about 30 inches. Some variations occur, as in the areas east of Aaronsburg on the flank of Brush Mountain, where the surface soil is somewhat sandy and the subsoil also of lighter texture. In the Bald Eagle Valley the soil ranges from 6 to 10 inches in depth and consists of a grayish-brown to yellowish fine-textured loam. In places a slightly sandy texture predominates and in others the soil is more silty. The latter variation is especially noticeable on the lower part of the slope which it occupies. In the Bald Eagle Valley more or less rounded sandstone gravel occurs on the surface and scattered through the soil.

The Dekalb loam is found in the valley section of the county, occurring as long, narrow areas at the foot of mountain slopes. Important areas extend along the Nittany Valley side of Bald Eagle Mountain, and along both sides of Nittany Mountain. In the Bald Eagle Valley a number of small areas are found extending from the confluence of Beech and Bald Eagle creeks up the latter to beyond Milesburg.

The surface configuration of these areas is gently rolling or sloping. That in the Bald Eagle Valley is a low, smooth ridge cut in a number of places by streams. The drainage is good. In some cases the run-off is rapid and the land is subject to erosion.

From its position and character this soil evidently represents the wash from the upper slopes spread over and intermingled with the material derived from the underlying shales and limestones; in other words, colluvial matter spread over residual. The colluvial material has been largely derived from the weathering of sandstones. In the Nittany and other valleys, with exception of Bald Eagle Valley, the underlying rock is mostly shale; in the last-named locality the Helderburg limestone is the underlying formation. Here the wash material has come from the Oriskany standstone and the whole has been reworked by water, as is evidenced by the rounded gravel found on the surface and in the soil mass.

This type of soil is easily cultivated and, lying well, it is almost all cleared and in farms. It formerly supported a growth of hardwoods, but now only occasional woodlots or forests exist. It is farmed to the usual crops of the region—corn, oats, wheat, and grass. These crops give excellent yields.

Potatoes are also grown quite extensively, the yield being good and the quality much better than in case of potatoes produced on the limestone soils. Corn yields from 60 to 70 bushels, oats from 35 to

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40 bushels, wheat from 15 to 20 bushels, and potatoes from 100 to 150 bushels per acre. With applications of lime this soil produces good crops of clover. In addition to the crops mentioned tomatoes and other heavy truck and canning crops would doubtless do exceptionally well. The value of farms on the Dekalb loam is much above the average for the county.

The average results of mechanical analyses of fine-earth samples of the soil and subsoil of this type are given in the following table:

Mechanical analyses of Dekalb loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
17076, 20065, 20067.	Soil.....	1.2	7.2	7.6	13.7	6.3	48.9	15.3
17077, 20066, 20068.	Subsoil.....	.7	3.9	6.9	12.3	6.1	38.2	31.6

DEKALB STONY LOAM.

The interstitial material of the surface soil of the Dekalb stony loam varies from a heavy sandy loam to a clay loam, with the predominating texture a medium loam. The color is brown or yellow brown. The subsoil is heavier, ranging from a clay loam to a clay, at depths of from 8 to 10 inches. It is generally impossible to bore over 15 inches into the soil, on account of the quantity of sandstone fragments, which form 15 to 60 per cent of the soil mass. These fragments are of all sizes and more or less subangular to rounded in shape.

Areas of the Dekalb stony loam are generally in forest. Where cultivated the stones have generally been picked off and piled. Bands of this soil are found along the slopes of the mountain ridges in the valley sections. The areas lie between the loam and clay loam types of the lower slopes and the Rough stony land of the crests and steep upper slopes. The surface varies from steep to gently sloping. There are practically continuous strips of this soil on both slopes of Bald Eagle Mountain and on the Nittany and other mountainous ridges. It also occurs on the north slope of Tussey Mountains. A few small scattered areas also occur in the plateau section of the county.

On the sides of the mountains its formation is due to the talus from the upper slopes mingling with the material derived from the lower lying shales, to which is due the fine texture of the soil. The talus consists mainly of sandstone which has become more or less broken and rounded in its progress down the slopes. The type may be considered largely a stony phase of the Dekalb clay loam. The upper portions of the areas, however, are to a great extent, if not entirely, of residual origin, derived from the disintegration of sandstones and sandy shales. These small areas in the plateau sections

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are also largely residual. Owing to its prominent topographic position and inclined surface the surface drainage is complete and in some localities so rapid as to result in damaging erosion.

Most of the Dekalb stony loam is covered with forest composed of a good growth of oak, hickory, chestnut, pine, and other valuable trees. But little of the type is cleared, and where it is, the land is devoted chiefly to pasture or meadow. It is best adapted to forestry and should be used for this purpose.

The following table gives the results of mechanical analyses of fine-earth samples of the soil and subsoil of the Dekalb stony loam:

Mechanical analyses of Dekalb stony loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
17092	Soil	0.5	10.2	11.7	21.5	10.5	35.3	10.2
17093	Subsoil	1.4	11.2	11.1	21.6	10.9	29.5	14.1

DEKALB FINE SANDY LOAM.

The surface soil of the Dekalb fine sandy loam to an average depth of 6 inches consists of a light-brown fine sandy loam. The subsoil has about the same texture as the soil, but is yellow or reddish yellow in color. Though of generally fine texture both the soil and subsoil carry some coarse grains, giving them a gritty feel. When moistened the subsoil shows the presence of considerable clay. Upon the surface and to some extent in the soil mass are found small weathered fragments of sandstone and some shaly flakes. In places, as on crests of the ridges, larger stones and bowlders occur and there are some outcrops of the underlying sandstone formation. Included in this type are narrow bands and small areas where the soil consists of 6 inches of light-brown to yellowish loamy fine sand, underlain by the same material, in places exceeding depths of 36 inches. These bands or areas occur on the crest of the ridge close to the disintegrating sandstone rock from which they have been derived. They were too small to be shown as a separate type in the map, and for that resaon were not differentiated.

The Dekalb fine sandy loam is of small extent and is found only in the Bald Eagle Valley, where it occurs as a few small narrow areas occupying the crest of a ridge. It is residual in origin, being derived from the Oriskany sandstone. The fine sandy loam is devoted to the general farm crops of the country and makes fair yields. It would no doubt be an excellent soil for truck crops. Potatoes do well, making fair yields of excellent quality.

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The following table gives the results of mechanical analyses of fine-earth samples of the soil and subsoil:

Mechanical analyses of Dekalb fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
20057	Soil	1.7	6.9	13.3	39.2	10.4	22.5	6.2
20058	Subsoil	1.5	6.4	10.5	31.3	10.4	27.7	12.0

DEKALB STONY SAND.

The fine-earth material of the Dekalb stony sand consists for the larger part of medium-textured sand or loamy sand, though there is a range in texture from rather coarse to fine. The immediate surface is dark colored, owing to a shallow covering of organic material. Beneath this the color becomes light gray to pale yellowish, the latter usually continuing through the subsoil, though in places the subsoil is a reddish yellow. The average depth of the soil is about 5 inches. There is practically no line of demarcation between soil and subsoil. There is usually enough clay and silt in the soil to make it slightly sticky, and in places the proportion is sufficient to give a heavy loam. On the other hand the soil in places is merely a partially disintegrated conglomerate rock, and it then has the texture of a coarse sand. These departures from the typical soil occur only in small areas. In both soil and subsoil are found more or less weathered and disintegrating sandstone and sandstone conglomerate. Here and there small outcropping ledges of these rocks also appear. The quantity of rock fragments increases with depth and there is very little fine sandy material below 2 feet from the surface. The stones, bowlders, and outcrops are always sufficient to interfere with cultivation. Where the stones are not too large and numerous they may be removed, and fairly cultivable fields are obtained in this way.

The Dekalb stony sand is the most extensive of the mountain and plateau soils. It occurs in the western part of the county in large bodies throughout the length of the plateau. A few small areas occur on Bald Eagle Mountain and on the other mountainous ridges of sandstone found in the valley portion of the county. It occupies the broad tops and gentle slopes of the ridges or stream divides of the plateau section. In some places it extends down the slopes to the stream banks, but here it is often displaced by Rough stony land. The Dekalb stony sand has been derived through weathering from the Pottsville and Pocono formations, the former largely a sandstone conglomerate and the latter a coarse-grained sandstone. The

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Pocono, however, does not enter to any great extent into this soil, as it usually gives rise to Rough stony land. These formations are of Carboniferous age. The Oneida and gray Medina sandstones also give rise to small areas of the Dekalb stony sand. As with most soils derived from sandstone the structure is open and porous and the natural drainage free, much of the rainfall passing into the soil.

Nearly all the area of this soil is still uncleared, although most of the merchantable timber has been removed. The forests consisted of white pine, jack pine, and hemlock; in the ravines, oak, chestnut, and some maple. At present it supports a scattering second growth of chestnut and oak, with some pine, where fires have not extended. An undergrowth of huckleberry, ferns, and bracken furnish browse for cattle.

Land of this character has a low agricultural value. It is limited in crop adaptation by texture and structure and by altitude, which confines its use to hardy plants and those that mature quickly. Low yields of wheat, rye, and oats are obtained on the few small areas cultivated. Buckwheat and potatoes can also be produced. The type should be used for pasture and forestry.

The results of mechanical analyses of the fine earth of a sample of the soil and subsoil are given in the following table:

Mechanical analyses of Dekalb stony sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
20051	Soil	9.5	38.5	13.8	11.6	4.2	17.7	4.7
20052	Subsoil	9.3	41.2	12.9	10.5	4.1	15.7	6.5

DEKALB SAND.

The surface soil of the Dekalb sand to an average depth of 5 inches consists for the most part of a medium loamy textured sand of light-gray to pale-yellowish color. Beneath this is found similar material slightly heavier in texture and more compact. The color of the subsoil is generally a deeper yellow than the soil and now and then becomes a reddish yellow. The immediate surface of most areas, these still being in forest, has a shallow covering of vegetable mold, giving it a darker color and greater loaminess than the material a short distance below. There is usually enough clay present to make the soil somewhat coherent when wet. When moderately dry and loose the soil is often slightly fluffy, especially when the texture of the sand is finer than usual. Variations in texture occur as in the Dekalb stony sand, a loose sand of almost any texture and from fine to coarse being found in some places and in others material of a texture approximating a light sandy loam. In depressions the soil is

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often quite silty. In the heavier phases the subsoil is also somewhat heavier and more sticky or plastic. A few sandstones and conglomerate fragments are found on the surface and in the upper part of the soil, and the quantity is often quite large even near the surface. Usually the underlying broken or weathered rock is found within 36 inches of the surface. The stone content, however, is rarely sufficient to interfere with cultivation, though occasional small stony areas, which, on account of their limited extent could not be shown as Dekalb stony sand, are included.

Only limited areas of the Dekalb sand occur in Center County. These are scattered over the western part and usually occupy level to gently rolling tops of broad ridges in the Allegheny Plateau section. The elevation of these areas averages close to 2,000 feet above sea level. Both position and character of soil promote ready drainage and the type is dry, warm, and, compared with the other soils of the section, early. It is residual and derived from the same sandstones and sandstone conglomerates as the Dekalb stony sand—the Pottsville formation.

Agriculturally the Dekalb sand has very little value. Practically none is cleared or under cultivation. In original forest growth and present condition it is very similar to the Dekalb stony sand. It can be purchased for a few dollars an acre. It is best for it to remain in forest, but some means must be found to check forest fires if practical forestry is to be made successful.

The average results of mechanical analyses of fine-earth samples of the soil and subsoil are as follows:

Mechanical analyses of Dekalb sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
20041, 20043	Soil	1.9	18.5	24.3	21.7	8.9	19.1	5.0
20042, 20044	Subsoil	1.4	4.9	22.4	19.0	7.6	23.4	11.1

UPSHUR STONY LOAM.

The surface soil of the Upshur stony loam, to a depth of 5 to 8 inches, consists of a fine loam, ranging in texture from silty to sandy. While the color is variable, the characteristic color is Indian red. Sometimes the immediate surface is brownish red and in places reddish brown. On the mountain slopes where affected by the wash from the gray sandstones above, the top soil is a more pronounced shade of brown or in places it is a yellowish color. The subsoil has quite uniformly the characteristic deep Indian red color, but it varies in texture from a silty to sandy loam, grading with depth into clay loam, or, as in the Bald Eagle Valley, is most often a clay loam grading

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into clay. When moistened and rubbed in the fingers, it has a smooth, shiny appearance and greasy feel, which is true to some extent of the soil, particularly the heavier phases. Upon the surface and in the soil there occurs from 15 to fully 40 per cent of shale and sandstone fragments, the content varying with the position. In the Bald Eagle Valley some of the slopes are exceedingly stony, and in general the proportion of coarse material is sufficient to necessitate removal before the land is cultivated. The stone consists of small chips, not flakes, of red shale and blocks of sandstone, the latter gray, brown, or red in color. In some areas the larger stones are lacking, in which case there may be a much larger quantity of small pieces with very little interstitial material. Such spots are most common on knolls in the areas on Bald Eagle Mountain and in the mountains of the eastern and southern parts of the county. The subsoil also contains stone, sometimes in larger quantities than the soil, but there is also much of it that has very little stone.

The Upshur stony loam is on the whole a friable easily cultivated soil, where the stone content is not so high as to interfere. The type is extensive. Its greatest development is in the Bald Eagle Valley, where it occurs as an unbroken belt of varying width extending the length of the valley. The other areas occur as long, narrow strips in the depressions or high valleys on the tops of mountainous sandstone ridges in the eastern part of the county. There are areas of this character on Bald Eagle Mountain, on Nittany Mountain, and on the Tussey Mountains. In the Bald Eagle Valley the topography consists of hills and ridges with steep slopes, rising in the highest parts fully 1,500 feet above sea level. As a whole the surface configuration is such that good drainage is afforded, but some slopes particularly on the Allegheny Mountain are wet and seepy.

The Upshur stony loam is of residual origin. It has been derived chiefly from two geological formations. In the Bald Eagle Valley it results from the Catskill consisting of red shale and red and brown sandstone of Devonian age. Here the Chemung formations of the same age enter into the material to a slight extent. The Catskill shale is mainly argillaceous, and the sandstone is medium to fine grained and interbedded with the shale. The red sandstone weathers to gray or dull brown. The areas outside of Bald Eagle Valley are derived from the Medina formation, also composed of red sandstone and shale.

With the exception of the limestone soils of the valleys the Upshur stony loam is the most productive and strongest of the residual soils of the county. It is retentive of fertilizers, easily improved, and is adapted to a wide range of crops. Wheat yields 10 to 20 bushels per acre. Oats give correspondingly good returns. From 30 to 60 bushels of corn per acre is secured. Timothy and clover do well, and potatoes

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yield as high as 250 bushels to the acre. It is considered the best fruit soil in the county, particularly for apples. The trees are thrifty, bear abundantly, and the fruit is of excellent quality, both as regards coloring and flavor. Every farm has its small orchard, but there are no large commercial orchards. The further development of fruit growing on this soil would seem to be one of its best uses. Though this land is some distance from the railroad, it brings the highest prices outside of the limestone districts for strictly agricultural land. The price seldom falls below $25 an acre and may be several times that amount.

The following table gives the average results of the mechanical analyses of fine-earth samples of the Upshur stony loam:

Mechanical analyses of Upshur stony loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
20075, 20077	Soil	1.3	2.6	1.6	17.4	25.9	38.0	12.7
20076, 20078	Subsoil	2.2	5.9	3.0	14.3	19.6	36.3	18.3

UPSHUR LOAM.

Occurring in troughlike locations between ridges of the Upshur stony loam are small areas of land lacking stone or carrying a relatively small quantity that have been mapped as the Upshur loam. This soil consists of 6 inches of a silty Indian red or brownish-red loam, underlain to depths exceeding 36 inches by a dark Indian red loam, grading through clay loam into clay.

Areas of this soil are found in the Bald Eagle Valley belt of the Upshur stony loam. Their total extent is small. In origin the type is residual, derived from the same class of rocks as the Upshur stony loam, though in places it has probably been influenced by wash from the surrounding slopes.

The areas have good drainage and are productive, giving good yields of the general farm crops.

The results of mechanical analyses of a typical sample of the soil and subsoil are given in the following table:

Mechanical analyses of Upshur loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
20079	Soil	0.4	2.1	1.3	4.9	12.7	58.3	20.1
20080	Subsoil	.9	2.7	1.5	4.9	10.6	47.9	31.3

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HUNTINGTON CLAY LOAM.

The surface soil of the Huntington clay loam has a depth of 8 to 10 inches and varies from heavy silt loam to silty clay loam of dark-gray, drab, dark-brown, or blackish color. This material rests on a subsoil of yellow or drab more or less plastic silty clay loam or clay; yellow and drab mottling of the subsoil is quite common, especially in the areas lying along Marsh and Bald Eagle creeks. Both the soil and subsoil are quite variable in color and texture, as is apt to be the case with soils of alluvial origin. The character depends upon the class of material of the watershed feeding the stream forming the deposits, the conditions under which the depositions were made and reworked, the drainage conditions, and in the amounts of organic matter contained. In the Nittany Valley it is the wash from both limestone and shale formations, while along Bald Eagle and Marsh creeks it is largely from shales.

This type occurs as narrow bands along the larger streams of the county, the largest and most important areas being found along Bald Eagle and Marsh creeks, in the Bald Eagle Valley, and along Spring and Sinking creeks in the Nittany Valley. The type occupies the low, level first bottoms and is subject to overflow. In the Bald Eagle Valley it is associated with the Moshannon loam and Moshannon fine sandy loam, these latter types occurring along the stream banks, while the Huntington clay loam lies next to the upland and is generally a little lower and is more or less wet. In these areas the soil mass has been largely derived from the contiguous slopes of the Devonian shale formations, while in the Nittany Valley the type owes in part its origin to wash from limestone soils.

Owing to moist conditions, the soil is best adapted to grasses for hay and pasturage, to which it is generally devoted, maintaining a good growth of pasture grasses during the whole season. Corn, oats, and wheat are grown to some extent on the areas where the drainage conditions are better.

The average results of mechanical analyses of samples of the soil and subsoil are given in the following table:

Mechanical analyses of Huntington clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
17072, 20069	Soil	0.5	2.6	2.9	8.1	8.3	52.4	24.4
17073, 20070	Subsoil	.1	1.1	2.4	11.5	14.1	45.5	24.6

HUNTINGTON GRAVELLY LOAM.

The surface soil of the Huntington gravelly loam to an average depth of 8 inches varies from a light to heavy loam, pale to dark-brown in

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color, as the drainage is good or imperfect. The subsoil consists of a yellow loam or clay loam usually resting on a bed of gravel within 24 inches of the surface. Gravel is also intermingled in the soil and subsoil and strewn over the surface. This coarse material consists of rounded sandstone pebbles and flat waterworn pieces of shale.

Only a small area of the Huntington gravelly loam is developed, a few areas being found along Bald Eagle Creek. They occur mostly on delta fans of streams entering Bald Eagle Creek. The material is transported from the surrounding areas by the streams and the soil is alluvial and closely associated with the Huntington clay loam. Because of its gravel content, the soil drains readily and is suitable for growing corn, of which good yields are secured. It also produces the other cereal crops.

MOSHANNON LOAM.

The Moshannon loam has a surface soil of brownish Indian red loam, 8 inches in depth, resting on a subsoil of texture and color similar to the soil, the texture becoming more sandy with depth. At 30 inches the material often changes to a compact fine sandy loam, though in places it becomes a heavy loam or clay loam. Some rounded gravel is found upon the surface and in the soil and subsoil in scattered areas, especially at the confluence of streams. Areas of the Moshannon loam occur associated with the Moshannon fine sandy loam along some of the streams of the county. It is typically developed between the Moshannon fine sandy loam and the Huntington clay loam, and where the latter is absent it lies between the former and the foot of the upland slopes. The areas are all small and not continuous along the streams. The largest areas are on the lower courses of Bald Eagle and Marsh creeks.

The Moshannon loam, like the Moshannon fine sandy loam, is of alluvial origin, representing the finer sediments deposited at a little distance from the stream. These sediments have been derived through erosion of the Upshur types of soil.

Of the bottom-land types the Moshannon loam is the most desirable in the sections in which it occurs. It is adapted to a wider range of crops than the Huntington soils and is fully as productive and as easily maintained in a high state of cultivation.

It produces the largest yields of corn, as much as 125 bushels of ears per acre being reported. This, however, may be regarded as exceptional, and a yield of something less than 100 bushels may be considered a fair average. Next to corn, the grasses and clover probably give the best results. Large yields of hay are harvested and exceptionally good pasturage afforded. Wheat and oats also make good yields, but the straw is liable to be heavy and lodging sometimes occurs. Areas not too wet give good yields of potatoes.

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The results of mechanical analyses of typical samples of the soil and subsoil are given in the following table:

Mechanical analyses of Moshannon loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
20073	Soil	0.0	0.5	0.6	17.9	26.6	38.8	15.7
20074	Subsoil	.0	.7	1.0	18.5	27.2	34.0	18.7

MOSHANNON FINE SANDY LOAM.

The surface soil of the Moshannon fine sandy loam consists of 6 to 8 inches of reddish or reddish-brown light to heavy fine sandy loam. The texture varies, and is sometimes a fine loamy sand and again it is of medium instead of fine texture. Even the fine-textured samples show considerable medium sand. Next to the streams the areas consist largely of bars of loose sand, while farther back the material becomes heavier. The subsoil is similar to the soil, except that it is sometimes more compact. It varies like the soil and is apt to be sandy or a sand or loamy sand in more cases than the soil. Gravel beds are usually encountered within the soil profile and there is often more or less rounded waterworn gravel on the surface. The color is the characteristic feature of this type, the Indian red distinguishing it at once from the Huntington series. The material has been washed from the Upshur types, derived from the red Catskill formation. Along Moshannon Creek, however, the color of the soil has a yellowish shade, the color being due to discolored water from coal mines.

Areas of the Moshannon fine sandy loam occur along streams, usually in narrow strips adjacent to the stream courses. In places the strips are so narrow that they could not be shown on the map without too great exaggeration and in such cases they were included in the heavier Moshannon loam. The aggregate area is small. Its greatest occurrence is along Bald Eagle and Marsh creeks and the small runs tributary to these streams. A few narrow strips occur along Beech Creek, and there are also some areas along Moshannon Creek, on the western boundary of the county. The soil is of alluvial origin. Occurring in the bottoms the areas are all more or less subject to overflow, but otherwise the drainage is good, except in the local depressions. The moisture conditions thus in the main are favorable to crop growth, but the soil is too sandy and gravelly to be a productive type except in the better parts. It produces fair crops of corn where manured and fair yields of potatoes. It is naturally suited to the production of garden vegetables.

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The results of mechanical analyses of fine-earth samples of the soil and subsoil of this type are given in the following table:

Mechanical analyses of Moshannon fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
20071	Soil	0.0	0.9	3.1	25.2	24.4	32.5	14.1
20072	Subsoil	.0	1.3	28.4	21.6	22.8	15.3	10.6

HUNTINGTON SANDY LOAM.

The surface soil of the Huntington sandy loam consists of 6 to 8 inches of a dark-brown to black heavy loam, rather sandy in places, and mixed with varying amounts of gravel and rounded stone fragments. The subsoil consists of a drab to black heavy silt loam to clay loam also containing gravel. In many places masses of rounded waterworn stones are encountered at 15 to 20 inches below the surface.

The soil occurs as first bottoms along the streams in the limestone valleys of the county and is generally level and often poorly drained. The soil is alluvial and is formed from the materials washed from the surrounding hills, reworked and deposited by the water. It has some of the characteristics of soil derived from the rocks of the immediate region, being usually the product of local erosion.

In places the type is utilized for the general farm crops, but usually it is in mowing land or pasture. Owing to its wet condition it is excellent for the pasture grasses, giving good grazing throughout the growing season.

The results of mechanical analyses of the soil and subsoil of this type are given in the following table:

Mechanical analyses of Huntington sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
17078	Soil	4.2	14.3	11.6	24.7	8.1	25.4	12.2
17079	Subsoil	.7	3.6	3.3	10.3	8.2	47.9	25.6

MEADOW.

Meadow includes the areas of low bottom lands that are too wet to be of use for tilled crops.

In some cases this land would be of value for cultivated crops if properly drained, but usually it is of such a character that reclamation is impracticable. It should be devoted to pasture where possible

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or left in forest growth. The extent of Meadow in Center County is small, and the type is therefore quite unimportant.

SWAMP.

Swamp, as mapped in Center County, comprises areas covered by water for the greater part of the year and supporting a growth of water-loving trees, shrubs, grasses, and rushes. Such areas are practically of no agricultural value, though in the driest part of the season cattle can be pastured on them. Swamp is found in three localities—along Moshannon Creek, on the western boundary of the county; at the head of Little Moshannon Creek in Rush Township, in the plateau section; and in the Tussey Mountains, in the southern part of the county.

ROUGH STONY LAND.

Throughout the mountain regions of the county occur many steep, tree-covered slopes that have been mapped as Rough stony land. The agencies of erosion have been so active in these areas as to remove practically all of the surface soil and to preclude the possibility of ever using this land for tilled crops. In some cases it can be used as pasture, some grass growing between the stones, but most of the type is covered by forests of hardwood, pine, hemlock, and trees of lesser value. Much of this land, notably on Nittany and the Tussey Mountains, is held as a state forest reserve. The balance is largely in the hands of lumber companies who are cutting off the merchantable timber. With a proper system of forestry this land should give good returns per acre in timber cut. It is worthless for general agricultural purposes, and all "cut-over" tracts should be reforested as rapidly as possible.

MADELAND.

A few very small areas in Center County are designated on the accompanying soil map as Madeland. These are places where mining has been done, excavations made, or lands dug over so as to change their position and topography, and at present have no agricultural value.

SUMMARY.

Center County is situated in the geographical center of the State. It is irregular in shape and one of the largest counties in the State, comprising an area of 715,520 acres, or 1,118 square miles. The western part of the county lies in the Allegheny Plateau, with an average elevation of about 2,000 feet above sea level. The remainder of the county consists of rolling limestone valleys, separated by narrow, sharp, mountainous ridges of sandstone.

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Center County lies in the drainage basin of the Susquehanna River, the western and central parts being drained by Moshannon, Bald Eagle, and Fishing creeks and their tributaries into the West Branch of the Susquehanna, which river forms the northern part of the western boundary of the county. Penn Creek drains the eastern part of the county into the Susquehanna itself. A little drainage in the south-central part of the county is effected by small streams that empty into the Juniata, another tributary of the Susquehanna. A feature of the drainage in most of the limestone valleys is the lack of surface streams, the run-off passing into sink holes and then into subterranean streams.

Settlement of the county was begun only a few years prior to the beginning of the Revolutionary war. The agricultural development of the county was slow for nearly half a century after settlement. The winters are cold with considerable snow, while the summers are comparatively cool. The growing season in the Allegheny Plateau section is so short that cultivated crops like corn do not always mature, and the tenderer vegetables can not be grown with safety. In the valleys, however, the season is long enough to mature all crops. The mean annual temperature at State College is 49° and the mean annual precipitation 40.2 inches.

General farming, consisting of the growing of cereals and grasses, supplemented on a small scale by dairying and stock raising, is the characteristic agriculture. The soils are suited to the production of these crops and practices and make comparatively good yields. The grain crops in order of acreage are wheat, corn, and oats, with barley, rye, and buckwheat of minor importance. A large acreage is devoted to the grasses for hay and pasturage. A little less than one-half the acreage of the county is in farms, of which about two-thirds is improved. The average size of the farms is 127.2 acres.

A little over one-half, or 56.3 per cent, of the farms are operated by the owners, the remainder are leased either on a share or cash basis.

With the exception of the alluvial soils found in the bottoms which comprise members of two soil series, the soils are closely related or associated with the underlying rock formations. The rocks underlying Center County are of sedimentary origin, ranging in geological age from Cambro-Silurian to Carboniferous, and consist of limestones, sandstones, and shales. The limestones have given rise to the Hagerstown series with five soil types represented. The sandstones and shales have formed the Dekalb and Upshur series. Another series occurs in the Barrens, the geological history of which is little known. These are poor, unproductive soils. The sandstones and conglomerates, besides giving a number of soil types, form considerable areas of Rough stony land, which are of no

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use agriculturally except for pasturage. Two other miscellaneous types having descriptive names are Swamp and Meadow. The bottom land soils represent two series, viz, Huntington and Moshannon. In all 30 types of soil, including as types Rough stony land, Meadow, and Swamp, were recognized.

The limestone or Hagerstown soils are recognized as the strongest and most productive soils of the county. The soils of the Upshur series are next in favor, and, besides being productive of the same general field crops as the limestone soils, are considered especially well adapted to fruit growing. The Dekalb soils as a class are considered poor soils. They are devoted to the same crops as the soils of the other series. The soils of the Morrison series are not extensive and are of little farming value.

Crop rotation is followed quite generally throughout the county. It consists of corn, wheat, oats, and grass cut for hay two seasons and then pastured for a year or two. Commercial fertilizers are used, supplementing barnyard manure and the clover crop. Liming is quite generally practiced.

The farming class in Center County is in a fairly prosperous condition. The wagon roads are good and railroad facilities excellent. There is a strong demand for all the products of the farms in the nearby towns. Modern means of communication, rural free delivery of mail, and rural telephone lines are available throughout the county. The section affords exceptional educational advantages.

Some improvement could be made in the dairy business by weeding out the unprofitable cows and by making more use of soiling crops. In general, the practice of green manuring to improve the soils should be extended. There is room for the extension of special forms of farming and horticulture. Fruit growing and the production of truck are perhaps the most profitable lines awaiting development.

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SOIL SURVEY OF ROBESON COUNTY, NORTH CAROLINA.

By W. EDWARD HEARN, assisted by G. M. MacNIDER and J. E. TURLINGTON, of the North Carolina Department of Agriculture.

DESCRIPTION OF THE AREA.

Robeson County lies in the southern part of the State of North Carolina, along the South Carolina line. It is bounded on the north by Cumberland County, on the east by Bladen and Columbus counties, on the south by the South Carolina State line, and on the

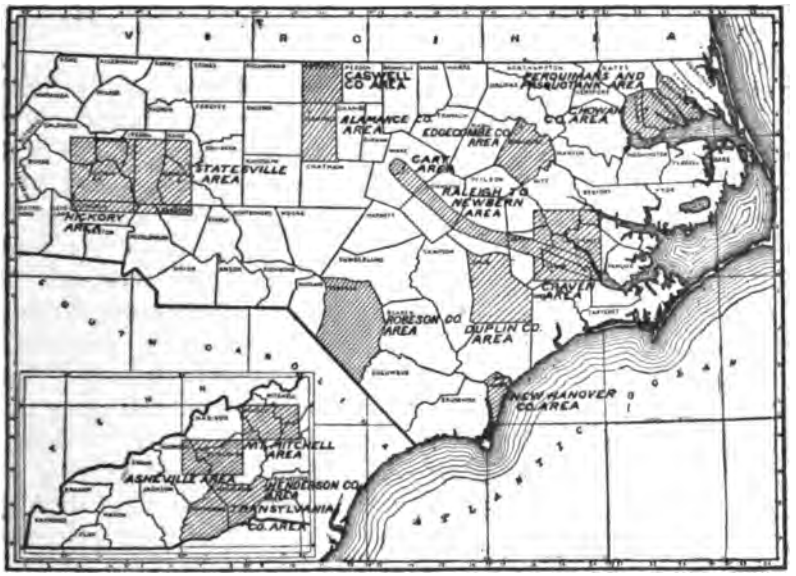

FIG. 6.—Sketch map showing location of the Robeson County area, North Carolina.

west by Scotland County. The county possesses a very irregular outline, following in most places the run of streams or the edge of swamp areas. It is the largest county in North Carolina, its greatest length from north to south being 52 miles, with a width varying from 25 to 37 miles. It has an area of 1,058 square miles or 677,120 acres.

The general surface features consist of level, undulating, gently rolling, and rolling areas, intersected by strips of swamp following the streams and dotted by many slight depressions and bays. The general slope of the county is to the south and southwest, and the difference in elevation of the two ends of the county is considerable.

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The largest level areas occur around Pembroke and in what is known as "Scuffle Town," in the vicinity of Bowmore, Dundarrach, to the southeast of Maxton, south and east of Lumberton, around Raynham, and to the west of Marietta. The surface of much of the county is undulating and very gently rolling, this being especially true around Rowland, Maxton, Red Springs, Parkton, McDonald, and Lumberton. The more rolling areas are found in the northwest corner along Lumber River, Rockfish Creek, and Big, Raft, and Ashpole swamps. No part of the county, however, is too rough or sufficiently broken to interfere with cultivation. The flattest and lowest areas occur along Lumber River in the southern part, where the largest bodies of swamp are found. The "Desert" is a conspicuous part of the topography, being an old lake practically surrounded by a ridge of sand. Many of the interstream areas are flat or undulating, becoming rolling as the streams or swamps are approached.

The regional drainage of the county is effected mainly through Lumber River, which forms a part of the western boundary, then flows across the county, and finally forms a part of the eastern boundary. Rockfish Creek flows along the northern end of the county. Big Swamp, Little Marsh, Big Marsh, and Ten Mile Swamp drain the northeastern and eastern parts of the county, while Big Raft, Little Raft, Richland, Long, Gum, Bear, and Back swamps drain the central part, the waters of all these emptying into the Lumber River. The southern and southwestern parts of the county are drained mainly by Leach and Shoeheel creeks, and Aaron, Hog, Indian, and Ashpole swamps. Lumber River and many of the other streams are swift flowing for such a flat country. Along the swamps are many dirt dams, which form ponds of varying sizes. There are 35 such ponds in Robeson County, and at 33 of them grist mills are operated by water power. At a few of these places some cotton is ginned and lumber sawed.

Robeson County was formed in 1786 from Bladen County, and named in honor of Colonel Robeson, who distinguished himself in the battle of Elizabethtown. The population consists of three separate and distinct races, the whites, the Croatans, and the negroes. The majority of the first white settlers were Scotch, and they located principally in the northern and western parts of the county. There were also some of English descent. The Croatans came from eastern North Carolina about 250 years ago and settled along Lumber River. These are said to be a mixed breed in which Indian blood predominates. It is asserted that a part of the "lost colony" left by Governor White on Roanoke Island, mixed with the Croatan Indians, and dwelt on the Neuse River until they moved to Robeson County. These people were declared a distinct and separate race by an act

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of the legislature in 1886. They have separate schools and churches, and have made wonderful progress within the last twenty-five years. They number 3,500 or 4,000, and live almost exclusively in the section in which Pembroke is located, thus occupying one-eighth or more of the county.

Probably not more than 30 per cent of the land in Robeson County is under cultivation. The largest percentage under cultivation lies around Rowland, McDonald, Red Springs, and Maxton. If all the swamps and depressions were drained there would be but little if any waste land, and if all the arable land were properly cultivated Robeson County could easily support several times its present population, which is about 45,000. Throughout the county are to be seen many neatly painted houses and other improvements which indicate, to a certain degree, the prosperity of the inhabitants. The farmers and landowners have made money in cotton and tobacco, and also on truck crops within the last few years. Much improved machinery, especially for cotton farming, is in use in the county.

Lumberton, the county seat, with a population near 4,000, is the principal town. Maxton and Red Springs have about 1,200 inhabitants each, Fairmont and Rowland about 800 each, while Parkton, Orrum, McDonald, Pembroke, Lumber Bridge, and St. Pauls are towns of less importance. Many smaller places and sidings for shipment of freight and express are conveniently located along the railroads.

Robeson County is well supplied with railroad facilities. It has the distinction of having as many different lines as any county in the State. The main line of the Atlantic Coast Line Railroad passes through the center of the county in a general northeast and southwest direction; the Bennettsville Branch of this system extends southwest from Parkton, crossing the county line near Maxton; the Southeastern Railroad, also a part of the Coast Line system, runs southwest from Elrod by Fairmont and thence east out of the county; the Aberdeen and Rockfish Railroad makes a swing into the northern part of the county; the Raleigh and Charleston Railroad runs south from Lumberton through the county; the Virginia and Carolina Southern Railroad extends north from Lumberton by St. Pauls; and the Wilmington and Charlotte Branch of the Seaboard Air Line Railway passes in a general east and west direction across the county.

The dirt roads are in fairly good condition. They have been worked in some townships by taxation. Good roads can be maintained in all parts of the county by a judicious mixing of the sand and clay materials at hand and by keeping the roadbed well rounded, so that the rain water will readily run off. Practically all of the county is well served by rural free delivery of mail. Neat schoolhouses and churches are to be seen throughout the rural districts.

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While there are no cities in the county, the towns afford good markets for many of the products. Tobacco warehouses are in operation at Lumberton and Fairmont, and more than a million pounds of tobacco is annually sold at each place. All the towns are markets for cotton. Watermelons, cantaloupes, and early truck of all kinds are shipped to northern markets, mostly to Baltimore, Washington, Richmond, Philadelphia, Pittsburg, and New York.

CLIMATE.

The climate of Robeson County is quite similar to the climate of a large portion of the Coastal Plain region. The winters are short and mild, while the summers are long and hot. Light snows fall nearly every winter, but rarely remain for more than a day or two. The spring and fall seasons are pleasant, and mild weather usually continues till Christmas. The prevailing breeze in the summer is from the south and southwest. It is generally conceded that the artesian water, pump water, and the drainage of certain wet areas have added greatly to the general healthfulness of the county.

The following table, compiled from the records of the Weather Bureau observer at Lumberton, gives the normal and absolute maximum and minimum monthly and annual temperatures, the mean monthly and annual precipitation, as well as the amount for the driest and wettest years, and also the average depth of snow. The rainfall is so distributed that the crops seldom suffer from severe drought and never fail to produce fair yields. The average date of the last killing frost in the spring is April 4 and of the first in the fall November 2. This gives a growing season of about seven months for the tenderest vegetation.

Normal monthly, seasonal, and annual temperature and precipitation at Lumberton.

Month.	Temperature.			Precipitation.			
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for driest year.	Total amount for wettest year.	Snow, average depth.
	°F.	°F.	°F.	Inches.	Inches.	Inches.	Inches.
December	44	74	13	3.1	3.3	5.6	0.5
January	43	76	8	4.0	2.2	4.0	1.9
February	41	74	1	4.9	5.9	2.2	2.9
Winter	43	.....	.....	12.0	11.4	11.8	5.3
March	53	85	18	3.7	2.5	3.6	T.
April	61	92	32	4.1	3.0	4.2	T.
May	71	98	39	4.3	3.4	12.5	0.0
Spring	62	.....	.....	12.1	8.9	20.3	T.

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Normal monthly, seasonal, and annual temperature, etc., at Lumberton—Cont'd.

Month.	Temperature.			Precipitation.			
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for driest year.	Total amount for wettest year.	Snow, average depth.
	°F.	°F.	°F.	Inches.	Inches.	Inches.	Inches.
June	77	101	50	5.3	2.3	5.5	0.0
July	80	102	55	5.8	2.6	6.5	0.0
August	79	101	53	6.0	4.5	7.0	0.0
Summer	79	.....	.....	17.1	9.4	19.0	0.0
September	72	97	35	3.9	3.3	9.4	0.0
October	62	92	29	3.5	4.4	1.2	0.0
November	52	82	15	2.4	4.3	1.0	0.0
Fall	62	.....	.....	9.8	12.0	11.6	0.0
Year	61	102	1	51.0	41.7	62.7	5.3

AGRICULTURE.

The agricultural products and methods of cultivation in Robeson County have changed decidedly within the last half century. In the early days of settlement many of the swamps were canebrakes, much wild peavine hay was seen, and many cattle were raised. About fifty-five years ago corn, rye, and flax were the principal crops, while some wheat and barley were also produced. Tobacco has always been grown, for a long time by the Croatans for home use. The turpentine industry was important about fifty years ago, and continued so for a good while, but in recent years it has declined as the timber was cut, until now only a few small stills are in operation in the county. Cattle, hogs, and sheep were raised in great numbers before the civil war. Considerable wool was shorn and marketed. Rice was one of the important crops for many years. The lumber industry was at its best about twenty-five years ago, the cutting of the forests of longleaf pine bringing a large revenue to the mill operators and owners. As the forest was cut, more land was cleared and brought under cultivation.

Soon after the war cotton became the staple money crop. About 1896, after cotton had been selling at a very low price for a few years, the farmers were eager to introduce some other money crop, and they began to grow bright-yellow tobacco on a commercial scale. Most of the tobacco has been grown by the small farmers or by those who live on the farm and superintend the work. Tobacco has been grown around Fairmont about ten years. At first the entire stalk was cut, but a few years ago the method was abandoned and the leaves are now pulled off as they ripen and are cured by artificial heat. The old method of cutting the entire stalk was not the best, because not

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all the leaves ripen at the same time, and consequently some would be overripe, while others would be green.

Most of the timber in Robeson County has been cut and only small tracts of the original growth occur here and there. There is a second growth coming on very fast, while most of the old growth remains in the swamp areas, which are thickly forested. Many sawmills are in operation throughout the county. There are large areas of cut-over, undeveloped land. In the past few years the trucking industry has become of considerable importance.

Robeson County produces more cotton than any other county in the State. Its production for 1907 was something over 47,000 bales. Cotton is grown upon all soils and in all parts of the county. Next in importance is corn, which is widely grown. The tobacco is confined to the eastern and southern parts of the county, between Lumberton and St. Pauls, and around Ashpole and Orrum. The average price is from 7 to 10 cents per pound, and about 2½ million pounds are sold annually at Lumberton and Fairmont. Oats are grown to a small extent. Sweet potatoes are grown for home use and local markets and some for shipment. Irish potatoes are produced in certain parts of the county for early shipment and for home use generally. One field of asparagus was seen just south of Maxton. From Maxton to Parkton along the railroad, especially around Lumber Bridge, watermelons, cantaloupes, English peas, sweet corn, beans, and tomatoes are grown for early shipment. Some cowpeas are grown with good results. Garden vegetables are produced around every home, the Norfolk soils and climate of this section being particularly suited to them. Peaches, pears, mulberries, and a few apples are grown. The Scuppernong grape, first cultivated by the Croatans, is now grown all over the county. A considerable income is still derived from the sale of lumber and shingles. The shingles are made from cypress or from the heart of dead pines.

Throughout the northeast and southern parts of the county the Norfolk sandy loam and the Norfolk fine sandy loam, where it has a depth of 15 to 20 inches above the sandy clay subsoil, are recognized as the best soils for tobacco. The Norfolk very fine sandy loam is devoted almost entirely to cotton and corn. The truck crops are grown on the lighter and deeper phases of the Norfolk sandy loam and to some extent on the Norfolk sand. Scuppernong grapes do well on the Norfolk soils, and, like peaches, do best on well-drained soils. Some of the well-drained Portsmouth soils, especially the sandy loams, are recognized as good soils for corn, oats, and cotton. Peanuts, a crop not grown at present, would prove very profitable and would help to make a complete rotation with tobacco, cotton, and corn. Ribbon cane would do well on some of the soils which are in a high state of cultivation. In many localities all the staple

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crops are grown upon the same type of soil, regardless of its adaptability to these crops.

The soils and climate of Robeson County are such that a variety of crops can be successfully grown, and a systematic rotation can be practiced. Cotton, especially on many of the larger plantations where the tenant system prevails, is grown year after year on the same land. Some of the farmers, however, rotate their crops by cultivating cotton two years, corn one year, and oats one year, sowing cowpeas at the last plowing of the corn and also after the oats are harvested. In the tobacco section more of a rotation is practiced, as usually only a few acres of each farm are devoted to tobacco. A good rotation would be cotton, peanuts, corn, and oats, sowing cowpeas at last plowing of corn and also after the oats are harvested.

The agricultural methods in Robeson County are being improved each year. Much modern machinery is now in use, such as cotton planters, fertilizer distributers, sulky plows, and cultivators for cotton and corn. Tobacco transplanters should be used by the farmers who grow tobacco, as they would save a great deal of hard labor. The Norfolk sand and Norfolk fine sand are so loose and open that the present methods serve fairly well. The Portsmouth soils, the Norfolk very fine sandy loam, and the heavier phases of the Norfolk sandy loam and Norfolk fine sandy loam should be plowed deeper and pulverized more thoroughly before the seed is planted. Some of the best farmers have found that this practice pays well. The old method of cultivating corn with a 1-horse plow, which necessitates hand hoeing, should be abandoned and improved cultivators used.

There is a general scarcity of efficient labor throughout the county. Most of the labor is performed by the negroes and Croatans. The Croatans are industrious workers and make fairly good tenants when supervised. The ordinary farm hand receives $15 a month with board, house, and garden patch. Many colored women work in the field and receive about 50 cents a day for chopping cotton. The men are paid from 75 cents to $1 a day for farm work.

A large proportion of the cultivated land in the county is worked by tenants, and these rent mainly under the share system. Under this system the landowner furnishes the land and all the fertilizers, and the renter furnishes the stock and implements, and does all the work, each receiving one-half of what is produced. Many of the landowners live in the towns. Perhaps a third of the tenants pay a stipulated rent, generally about a 500-pound bale of cotton for every 10 acres, though the amount depends on the quality of the land. On some of the farms the owners hire help and till their own land. Most of the small farms and some of the larger ones are operated directly by the owners.

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The size of the farms varies from 50 to several hundred acres. On the southwest corner and in certain sections north of Lumberton the size ranges from 100 to 300 acres, while in other sections many smaller farms are common, especially among the Croatans.

Land values have greatly increased in Robeson County within the last few years. Much of the best improved land around Red Springs, Maxton, Rowland, and Lumberton is held at from $40 to $100 an acre; around Fairmont and in many other sections from $20 to $35 an acre; while the cut-over land, with its stumps and scattering growth, will sell from $8 to $12 an acre.

The soils in Robeson County are heavily fertilized. Many of the renters and small farmers buy a complete fertilizer, either 2–8–2[a] or 3–8–3, while some of the largest planters buy cotton-seed meal, acid phosphate, and kainit and do their own mixing. As a rule, from 400 to 800 pounds per acre is applied. From 600 to 800 pounds per acre of an 8–5–7 fertilizer is used on watermelons, cantaloupes, beans, peas, Irish potatoes, and other truck crops. More cowpeas should be grown in order to supply humus to the soil. This would also obviate the necessity of buying so much high-priced nitrogenous fertilizer and would save thousands of dollars, at the same time greatly improving the land. More machinery could be used advantageously. A systematic rotation of crops should be practiced whenever conditions warrant. Peanuts can be grown profitably in the rotation as a money crop. Deeper plowing and a better preparation of the land would give increased yields. Every farmer should produce sufficient corn and hay for feeding stock, and more hogs should be raised. Cowpea-vine hay is an excellent feed for all stock. Robeson County offers great opportunities, and the present tendency is toward a higher development of its agricultural interests.

SOILS.

Robeson County lies within the Atlantic Coastal Plain region. The entire area is covered by the Columbia formation, but in a few spots in the southern part near Rowland this formation is very thin and the outcropping of the Lafayette formation is seen, thus giving rise to small spots of Orangeburg fine sandy loam with its distinctly red subsoil. The Columbia formation consists of sands, sandy loam, silts, and clays. The materials were brought down by the streams from the Piedmont Plateau and deposited in the sea when this portion of North Carolina was covered by the Atlantic Ocean. Wave action has played an important part in sorting and redepositing the different grades of soil material; thus the stream currents and waves account largely for the occurrence of soils of different texture in the

[a] Formulas stated in this order: Nitrogen, phosphoric acid, potash.

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county. In the southern and southeastern parts of the county the soils are finer in texture than those in the northern and western parts.

The large areas of swamp are composed of these materials which have been transported and deposited by the streams during periods of overflow. Many of the sand areas have also been formed by deposits from the swift currents of the streams. The Sandhill and perhaps portions of the sand areas have been thrown up by wave and wind action. Many of the cypress bays and other depressions and the "Desert" were small lakes which were cut off by ridges of sand and thus separated from the main drainage ways. Erosion has played little part, except on the rolling areas and slopes where an appreciable amount of the finer material has been washed out.

In the southern part of the county shell marl occurs in many places at from 4 to 8 feet below the surface. Some of it has been used as fertilizer in recent years along Wilkinson Swamp and about 1½ miles east of Ashpole. Artesian water can be had at from 90 to 150 feet over a large part of the county, especially around Fairmont, Lumberton, and Fairbluff, and to the north of Lumberton.

The sedimentary soils in Robeson County are typical of the soils of the Atlantic and Gulf coastal plains. These soils have been classed into two distinct series—the Norfolk and the Portsmouth. The Norfolk series comprises the light-colored soils, underlain by yellow or brown sand, sandy clay, or loam. By reason of their topographic position the surface drainage is fairly good. The Portsmouth series comprises the dark-colored and black soils which are underlain by mottled gray sandy clay and clay. They occupy the level and depressed areas and have very poor natural surface drainage, being in many places in a semiswampy condition. The Portsmouth soils are derived from the same kind of material as those of the Norfolk series. They have been for a long time in a semiswampy condition which has favored the accumulation of large quantities of vegetable matter, and this has given them their dark color.

Eleven distinct types of soil were mapped in the county. Among these are included Sandhill and Swamp, which under present conditions are nonagricultural types. The following table gives the name and extent of each of the several types of soil:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Norfolk sandy loam	297,152	43.8	Norfolk fine sand	9,280	1.3
Swamp	108,800	16.6	Portsmouth loam	2,624	.3
Norfolk fine sandy loam	105,920	15.6	Orangeburg fine sandy loam	1,536	.2
Portsmouth sandy loam	62,080	9.1	Sandhill	960	.1
Norfolk sand	51,648	7.6			
Norfolk very fine sandy loam	26,880	3.9	Total	677,120	.....
Portsmouth fine sandy loam	10,240	1.5			

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NORFOLK SANDY LOAM.

The surface soil of the Norfolk sandy loam consists of a gray, yellowish-gray, or light-brown, medium to coarse sandy loam, varying in depth from 8 to 30 inches. It is locally spoken of as "gray land." Around Pembroke and in the vicinity of Bowmore the soil is a gray, medium to coarse sandy loam, about 8 to 12 inches deep. In a few of the low-lying forested areas the first few inches is dark gray in color, due to the accumulation of vegetable matter, while on some of the ridges which have been cultivated for a long time the soil is light colored. A considerable portion of the surface soil is light brown in color. Along Lumber River and in the southwest corner of the county and near many of the swamps and streams a rather coarse sandy loam is found. Between the gray or brown surface soil and the yellow, sandy clay there is a stratum of yellow medium to coarse, sandy loam. This soil is cultivated with ease and its position allows the use of modern machinery for practically all areas. Over the larger and more uniform areas the subsoil is a yellow, sticky, sandy clay, and in a few localities it is a yellow, sticky, sandy loam, especially sandy near the areas of Norfolk sand. A reddish-yellow or brown sandy clay was seen in a few places near the streams. Near the river and other large streams some coarse sand and fine gravel are mixed with the sandy clay.

The Norfolk sandy loam is the most important and most extensive type in the county, covering about 44 per cent of the area. It is the principal soil in the northern, central, and western parts of the county. It is typically developed around Parkton, Dundarrach, Bowmore, Red Springs, Maxton, Pembroke, St. Pauls, north and west of Company Mills, along the Coast Line Railroad from Pembroke north, and along the Seaboard line from Maxton to near Lumberton. A large area occurs south of Lumberton, in Britt Township, and a large body follows Ashpole Swamp.

The surface features of the type vary from level and undulating to rolling areas. The largest, flattest areas occur in the vicinity of Pembroke, throughout part of "Scuffle Town" around Bowmore, southeast of Rennert, west of Dundarrach, and southeast of Maxton. The main interstream areas are usually flat and undulating, with a gradual slope toward the streams, becoming more rolling as the swamps and streams are approached. Open ditches have been cut and are in general use over these flat areas. More of these artificial drains are needed to drain thoroughly and dry out the soil for cultivation. Most of the undulating and all the rolling areas possess good natural surface drainage. All of this type could be artificially drained and brought under cultivation. Much of the land now tilled would be greatly benefited by better drainage.

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The Norfolk sandy loam is sedimentary in origin and is derived from the weathering of the sands and clays of the Columbia formation. On the gently rolling areas and slopes the material has been subjected to considerable washing and the rain waters have carried away a large amount of the finer material, leaving a deep, light sandy loam, while on the more level areas the soil contains a larger proportion of clay and is slightly more compact. The forest growth at present is longleaf, loblolly, and shortleaf pine, with some scattering dogwood, hickory, and oak. Very little of the merchantable longleaf pine now remains.

The Norfolk sandy loam is the best general farming soil in the county. It is well adapted to the production of cotton, peanuts, tobacco, Irish potatoes, sweet potatoes, corn, and cowpeas. The truck crops, such as watermelons, cantaloupes, beans, English peas, tomatoes, sweet corn, and asparagus do well on the lighter and deeper phase of this type. It is a good soil for the Scuppernong and other grapes, peaches, pears, and mulberries. Cotton yields from one-third bale to 1¼ bales to the acre, the average yield by tenants being about one-half bale. The largest yields are secured by good cultivation and heavy applications of fertilizer. Corn yields from 10 to 40 bushels per acre, sweet potatoes from 50 to 200 bushels, tobacco from 700 to 1,400 pounds, and oats from 20 to 40 bushels. Watermelons, cantaloupes, Irish potatoes, English peas, beans, tomatoes, and sweet corn are grown with a fair degree of success around Maxton, Lumber Bridge, and Parkton for early shipment. The truck crops are heavily fertilized, and also the tobacco and most of the cotton. For watermelons 7–8–5 grades are used and for sweet potatoes the 3–8–3, the latter being used also for tobacco and part of the cotton.

The soil needs to be plowed deeper and pulverized more thoroughly before the seed is planted. It holds manures fairly well and can be easily maintained in a state of high productiveness. By plowing under cowpeas and coarse manures and adopting a systematic rotation of crops this soil would soon produce good yields without much commercial fertilizer. A little lime would probably prove beneficial, especially if peanuts were grown.

The Norfolk sandy loam brings from $20 to $30 an acre in remote sections of the county, while near Red Springs, Maxton, and Parkton it sells at from $30 to $75 an acre.

NORFOLK FINE SANDY LOAM.

The Norfolk fine sandy loam to a depth of about 6 inches is a gray or yellowish-gray fine sandy loam, grading into a yellowish fine sandy loam which extends to a depth of 10 to 30 inches. In the forested areas the first few inches of soil is dark gray in color, owing

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to the accumulation of considerable organic matter. The average depth of the fine sandy loam surface is about 12 or 15 inches, and the yellow stratum is always encountered before the sandy clay is reached. In a few localities a light brown fine sandy loam is seen. In addition to the typical soil there are two noticeable phases. Around Rowland where this type joins the Norfolk very fine sandy loam, around Barnesville, and to the south of Orrum, the soil is slightly heavier in texture and the subsoil is nearer the surface than the average of the type. This phase is considered by some as the best part of the type. To the north of Orrum, east of Fairmont, and several miles northeast of Lumberton, in the "meadow section," the soil is from 20 to 30 inches deep, being a light, fine sandy loam, and not quite so productive as the average soil of this type.

The subsoil is a yellow, sticky, fine sandy clay or yellow, sticky loam. In a few localities a yellowish-brown or reddish sandy clay is encountered.

The Norfolk fine sandy loam is developed in the eastern and southern parts of the county. One large area lies to the east and northeast of Lumberton, extending to near the county line and along the Seaboard Air Line Railroad. The largest area, which is of very irregular outline, lies in Britt, Whitehouse, Back Swamp, and Sterling townships, being well developed along the Raleigh and Charleston Railroad, around Center Church, Barnesville, Proctorville, Fairmont, and Rowland.

The topography of the Norfolk fine sandy loam varies from level to rolling. Near the streams and swamps and in the vicinity of Fairmont the surface is undulating to gently rolling. Perhaps the flattest area lies about 3 miles northeast of Lumberton. Many of the interstream areas are flat, with a gentle incline to the streams. The natural surface drainage of the rolling areas is good and the soil dries out early in the spring. The areas have to be artificially drained, but this can be accomplished quite effectively by canals and open ditches leading into the natural drainage ways.

This soil is sedimentary in origin and is composed of the finer materials of the Columbia formation. In a few places the subsoil seems to be slightly modified by the Lafayette material, as a red sandy clay is found. On the rolling areas the soil is light and loose, while on the flat areas it is heavier and the subsoil nearer the surface. However, all areas of this soil are mellow and very easily tilled.

This soil type was once forested to longleaf pine, but most of the merchantable timber has been cut. Considerable loblolly and shortleaf pine were seen, and a few scrub oaks have come up where the land has been allowed to reforest itself. A large portion of this type

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is as yet undeveloped and offers opportunities for the production of both general and special crops.

The Norfolk fine sandy loam is well adapted to the growing of bright tobacco, peanuts, cotton, sweet potatoes, Irish potatoes, watermelons, cantaloupes, grapes, peaches, berries, and all kinds of truck crops. The tobacco does best where the soil is from 12 to 20 inches deep, while cotton, corn, and oats do best where the soil has a depth of 8 to 12 inches. Cotton yields from one-third to 1 bale per acre, corn from 8 to 30 bushels, and tobacco from 600 to 1,200 pounds. Oats do fairly well. Irish potatoes, sweet potatoes, and truck crops do well, though only a few such crops are grown. Scuppernong grapes, peaches, and mulberries give fair returns.

This soil on account of its position and mellow texture permits the use of all kinds of improved machinery. Commercial fertilizer is used on all the cultivated crops. The tobacco, perhaps, receives the heaviest applications, as from 600 to 1,000 pounds is commonly used to the acre. This soil is capable of great improvement. The rotation of crops, plowing under cowpea vines, or even the stubble, or crimson clover would add the needed humus to the soil and also increase its water-holding capacity. This type of soil sells at from $10 to $40 an acre.

NORFOLK VERY FINE SANDY LOAM.

The surface soil of this type in the cultivated areas is a gray very fine sandy loam to a depth of 6 to 12 inches. In the forested areas and in a few depressions the surface soil is dark gray in color. Below the first few inches a yellow very fine sandy loam is encountered, and this extends to the yellow silty loam subsoil, which is generally found at from 6 to 12 inches. This type is composed largely of very fine sand and silt, with relatively small amounts of clay and the various other grades of sand. It is a mellow, friable, and easily tilled soil, and one upon which improved machinery can readily be used.

The subsoil is a yellow or light-brown silty loam or loam to a depth of several feet. In a few localities the subsoil is mottled or of a reddish color.

This type is confined exclusively to the southern part of the county. There are two large areas, one occurring around Raynham and McDonald, and the other in the vicinity of Rowland. Smaller bodies are found near Marietta and Orrum and one east of Barnesville. Most of this type, however, is developed in Thompson Township.

The surface of the Norfolk very fine sandy loam varies from level to undulating and very gently rolling areas. It lies well for general farming purposes. Some of the gently rolling areas possess fairly good surface drainage, while the level areas have to be artificially

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drained to bring the soil into condition for crops. Open ditches have been dug throughout areas of this type, and much of it needs better drainage in order to secure more profitable returns.

This type owes its origin to the deposition of the finer sediments which were brought down from the Piedmont Plateau and deposited on the floor of the sea. Erosion has not been active except on a few of the knolls and gently rolling areas, where some of the silt and clay or most of the surface soil has been washed away, leaving the yellow subsoil exposed in a few places.

The native forest growth was longleaf pine, the most of which has been cut, only a few patches remaining here and there. Some loblolly was seen and in a few depressions gums were noticeable. A considerable part of the type is under cultivation. It is recognized as one of the very best soils in the county for cotton, corn, and oats. It holds manures well and responds readily to fertilizers. Cotton yields from one-half bale to 2 bales per acre, with an average of about two-thirds bale. All of it is fertilized; as high as 1,000 pounds of fertilizer per acre is applied in some fields. Corn yields from 10 to 40 bushels per acre, and oats do fairly well. On some of the highest places some tobacco is grown with fairly good success. It would produce peanuts and late truck crops. When plowed shallow the soil has a tendency to bake. It should be plowed deeper and more thoroughly pulverized before planting.

The Norfolk very fine sandy loam is a highly prized soil and sells at from $30 to $60 an acre, some of it near Rowland and McDonald being valued at $100 an acre.

The following table gives the results of mechanical analyses of samples of this type of soil:

Mechanical analyses of Norfolk very fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18823, 18825	Soil	0.1	1.1	1.1	20.6	38.4	30.6	6.9
18824, 18826	Subsoil	.1	.8	.6	14.8	21.0	27.6	34.6

NORFOLK SAND.

The Norfolk sand is a yellowish-gray, gray, or light-brown, medium to coarse sand, having an average depth of 4 to 6 inches. On some of the knolls and in a few fields which have been in cultivation for a long time a whitish or yellowish sand is found, and in some places along the streams a brown coarse sand is seen. In many depressions of this type are found spots of Norfolk sandy loam. The soil is loose and porous and very easily tilled.

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The subsoil is a yellow medium to coarse sand to a depth of 36 inches or more and is loose and incoherent. Along Shoeheel swamp south of Maxton, and in a few other localities it is a reddish sticky sand. Along the margin of the Norfolk sandy loam the yellow sand often grades into a light sandy loam at and below 30 inches. A little gravel is present in both soil and subsoil in some areas near the streams.

Most of the Norfolk sand occurs in the northern part of the county, though small bodies and strips of it are of frequent occurrence along the swamps throughout the county. The largest areas are found east of St. Pauls, along Gallberry swamp, Rockfish Creek, Lumber River, and north of Floral College. There were many spots too small to be shown on the soil map.

The Norfolk sand occupies the knolls, ridges, and highest elevations in the county, and its surface for the most part is gently rolling to rolling. The more rolling areas are found along Rockfish Creek and Lumber River in the northern part, and along the swamp area in other parts of the county. The more gently rolling areas are remote from the streams, while the flat areas lie along Lumber River, in the southern part of the county. The open, loose texture of this soil and its high position give it excellent surface drainage. The rainwater percolates rapidly through both soil and subsoil, thus allowing it to warm up early in the spring and to be cultivated immediately after a rain.

This type owes its origin to the weathering and reworking of the coarser materials of the Columbia formation. Evidently many of the areas of sand have been modified or entirely formed by stream action. A considerable quantity of the finer particles have been washed out, leaving the coarse and medium sand. Some of the areas along Lumber River have been formed by the action of that stream during times of overflow and swift currents. Some of the dunelike areas or knolls are droughty and rather unproductive.

Much of this soil is under cultivation. The larger portion, however, is covered by a growth of scrub oak, old-field pine, and some longleaf pine. The Norfolk sand is too light for general farming purposes, but is splendidly suited to early truck crops, melons, Scuppernong grapes, peaches, mulberries, and pecans. Peanuts would be a fairly profitable crop on this sand if a liberal application of lime were used. All crops mature early. Cotton yields from one-fourth to one-half bale per acre, depending upon season and amount of fertilizer used. Corn gives fairly good yields when manured or when it follows cowpeas. Cantaloupes, watermelons, beans, Irish potatoes, sweet corn, and asparagus do well. Shallow plowing meets every demand on this loose, open soil. Commercial fertilizers are used in the growing of all crops. The truck crops are heavily fer-

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tilized. The soil needs more humus, and this should be supplied by growing cowpeas or adding coarse manures. These would not only supply the deficient nitrogen but would make the soil loamy and more retentive of moisture.

The Norfolk sand ranges in value from $10 to $30 an acre, depending on location.

NORFOLK FINE SAND.

The surface soil of the Norfolk fine sand is a yellowish-gray, gray, or light-brown mellow fine sand to a depth of 6 inches. In a few places on the knolls a whitish fine sand occurs, such areas being less productive than the true type, while in a few areas near some of the streams a brown sand is found. The subsoil to a depth of 36 inches is a yellowish fine sand, loose and incoherent, except near the margin of the Norfolk fine sandy loam, where it grades at 30 inches into a sticky, fine sandy loam.

This type occurs in many areas in the southeastern part of the county, being associated with the Norfolk fine sandy loam. Some of the most prominent areas lie on the east side of Hod Swamp, to the southeast of Lumberton, in the vicinity of Smith's mill, near Princess Anne, and south of Barnesville.

The Norfolk fine sand occupies the gently rolling knolls, ridges, and undulating areas, being more rolling near the streams. It bears the same relation to the Norfolk fine sandy loam as the Norfolk sand does to the Norfolk sandy loam. By virtue of its position and open texture the natural surface drainage is good. It is a warm, well-drained soil, and one upon which farming operations can be carried on soon after a rain.

This type is sedimentary in origin and represents some of the coarser material sorted out by wave and stream action. Some areas near the streams have been formed by the action of swift stream currents. Only a small percentage of clay and silt is found in this soil. The soil being finer in texture is not quite so leachy as the Norfolk sand.

This type was once forested to longleaf pine, most of which is now covered with old-field pine, scrub oaks, and sweet gum bushes.

The Norfolk fine sand, like the Norfolk sand, is too light for profitable general farming. It is, however, especially suited to early truck crops, peaches, berries, mulberries, melons, asparagus, and Scuppernong grapes. It would also produce peanuts with better results than it does the staple crops now grown. Cotton yields from one-fourth to one-half bale per acre, corn 5 to 20 bushels, and tobacco from 500 to 800 pounds. Oats give light yields. All crops are fertilized, the cotton and tobacco receiving the heaviest applications.

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This soil is quite deficient in humus, and crop rotation, including cowpeas, should be practiced. The cowpea vines if turned under would supply the needed humus and greatly improve the soil. After turning under cowpea vines and coarse manures a little lime would further increase the yields. This soil could be brought to a fairly good state of productiveness, as has a similar soil around Norfolk, Va.

Land of this type sells at from $10 to $25 an acre.

PORTSMOUTH SANDY LOAM.

The soil of the Portsmouth sandy loam to a depth of 6 to 15 inches is a dark-gray or black, medium to coarse sandy loam. The gray phase is usually under cultivation, while the heavy black phase, locally known as black land, occurs in the forested and poorly drained areas. In a few areas spots of loam and fine sandy loam were encountered, thus giving a considerable variety in texture.

The subsoil is a light-gray, sticky sandy clay mottled with brown and sometimes red or yellow. Just south of Lumberton a yellowish mottled clay is found. In a few localities a white sand or gray sandy loam containing coarse sand and gravel is encountered at from 20 to 30 inches. Much of the subsoil holds water well and acts like an impervious clay.

The Portsmouth sandy loam is scattered throughout the county, being closely associated with the Norfolk sandy loam and Norfolk sand and having its greatest development in the northern and central parts. Some of the largest areas are to the east of Beulah Church, south of Lumberton, southeast of Maxton, and along the Virginia and Carolina Southern Railroad. A large area lies about 2 miles east of Gaddysville. Spots and strips too small to be shown on the soil map were seen in many places in the Norfolk sandy loam.

The soil occupies level and slightly depressed areas, formerly known as cypress bays and ponds, which are usually elliptical or round in shape. It is commonly bordered on the east by a ridge of Norfolk sand. There is very little natural surface drainage, and all the cultivated areas have been drained by open ditches. Many of the wet, semiswampy areas could be drained by digging deep ditches to some of the natural drainage outlets. Some of the type along Lumber River, being only a few feet above the water table, would be difficult to drain until the water table of that stream is lowered.

The Portsmouth sandy loam is composed of the coarser material of the Columbia formation, which has been modified by the wash of fine material and the accumulation of large amounts of organic matter. The wet and swampy condition for a long time favored the growth and decay of vegetation. Some areas along the river have been considerably modified by stream action.

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Most of the forest growth on this type has been cypress, gum, and pond pine, with an undergrowth in many places of water-loving shrubbery, consisting of gallberry, huckleberry, etc. Loblolly and shortleaf pine grow on some of the better drained areas. This soil, when good drainage has been established, is well suited to corn, oats, cotton, cabbage, onions, strawberries, and garden vegetables. It ranks as one of the best corn soils in the county. All crops do best on this soil during a warm, dry spring. Corn yields from 15 to 30 bushels per acre, and sometimes as high as 50 bushels; oats about 30 to 40 bushels; and cotton from one-third to one bale. Crab grass makes good hay, and cowpeas do well. The soil is fairly easily tilled, and machinery can be used to good advantage.

The Portsmouth sandy loam requires in many instances a less amount of nitrogen than the Norfolk types, but it needs considerable potash and phosphoric acid. Liming pays well and the effects are quite lasting. Much of this land is as yet undeveloped, and is low priced, while the drained and cultivated areas sell at from $20 to $50 an acre.

PORTSMOUTH FINE SANDY LOAM.

The surface soil of this type consists of a dark-gray to black fine sandy loam from 6 to 15 inches deep. The cultivated areas consist of a dark-gray soil, while the forested areas have a black surface soil. Occasionally in some of the bays a black mucky soil a few inches in depth is seen. Spots of silt loam and loam too small to be mapped are numerous in this type.

The subsoil is a gray, mottled with brown or sometimes red, sticky fine sandy clay extending to a depth of 36 inches or more. In some places a sandy loam or sand is encountered at 30 inches, while in others a silty loam or clay is found. Iron crust forming a hardpan is sometimes present in the subsoil.

The Portsmouth fine sandy loam occurs in the eastern and southern parts of the county. The largest areas lie to the north and northeast of Lumberton, north of Bellamy, and in Britt Township north of Proctorville. Many small spots are present throughout the Norfolk fine sandy loam areas. This type occupies level, flat areas, depressions, and bays, and is usually lower than the surrounding soils. A considerable part of it in the bays is in a semiswampy condition, with the water table near the surface, and some of it is covered with water during the winter season. The type has no natural surface drainage, and the areas which are cultivated have been drained by open ditches. Much of this soil can not be drained easily except by cutting very deep ditches from the bays to some of the natural drainage outlets, and if this were done some valuable land could be brought under cultivation.

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This soil represents some of the finer sediments of the Columbia formation, to which have been added large amounts of organic and fine material from surrounding soils.

Some of the higher and better drained areas are forested to loblolly pine, while on the poorly drained and swampy areas the typical swamp forest of gum and cypress is found. To the east of Lumberton the pond pine, with a dense undergrowth of gallberry, myrtle, and huckleberry, constitutes the growth on several areas.

Only a few small areas are cultivated, and the principal crops are corn, cotton, and oats. Fairly good yields are secured. Strawberries, onions, cabbage, and the staple crops will do well where the soil is well drained. Perhaps lime would benefit some areas. Practically all of the type is forested or has been cut over, leaving a few small trees and a thick undergrowth.

PORTSMOUTH LOAM.

The soil of this type is a mellow silty loam to a depth of about 6 inches, varying in color from a dark-gray in the cleared and cultivated areas to a black in some of the forested areas. The subsoil is a gray, mottled with brown or red, silty clay or clay.

The Portsmouth loam is of small extent in the county, occurring, as it does, in small spots and as depressions in the Norfolk very fine sandy loam around Raynham, McDonald, and Rowland. It has a very flat and level surface and only in a few places has it been sufficiently drained to be cultivated. Part of the type is in a wet and swampy condition and even the cultivated areas need better drainage.

This soil was deposited in quiet water, and hence it contains only a small amount of the medium and coarse grades of sand, the larger percentage of it being fine and very fine sand, silt, and clay. The type has been covered with vegetation most of the time, and considerable organic matter has accumulated in the soil. Gum, a little cypress, and some shortleaf pine constitute the forest growth.

When better drainage is established corn, cotton, and oats will do well on this soil. The crops now grown are corn and oats, with only ordinary yields. It is a strong soil and would have about the same value as the surrounding types if it were well drained.

The results of mechanical analysis of this soil are given in the following table:

Mechanical analysis of Portsmouth loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18843	Soil	0.2	1.5	1.3	19.5	19.0	37.5	20.4

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ORANGEBURG FINE SANDY LOAM.

The surface soil of the Orangeburg fine sandy loam is a gray or brown fine sandy loam to a depth of 6 to 15 inches. In a few places the sandy surface covering has partly eroded off, leaving a red loam exposed. The subsoil is a bright-red heavy sandy clay or silty loam, being somewhat heavier in texture than the subsoil of the Norfolk fine sandy loam.

There are only a few small bodies of Orangeburg fine sandy loam in the county. These lie near the South Carolina line, within a short distance of Rowland, the largest one being just south of Echo. The type occupies slight ridges and knolls. It is well drained and ditching is seldom necessary.

The Orangeburg fine sandy loam is derived from the weathering of the sands and clays of the Lafayette formation. The surface scil has been changed to some extent by erosion, as the rain waters have washed away part of the clay and silt, leaving a mellow fine sandy loam. This soil was forested to longleaf yellow pine. Now practically all of it is cleared and cultivated. It is well suited to the production of cotton, tobacco, corn, and truck crops. Cotton yields from one-half to 1 bale per acre with liberal fertilization, corn from 20 to 30 bushels, while garden vegetables and fruits do well. The land has about the same money value as the Norfolk very fine sandy loam.

SWAMP.

The soil in the areas mapped Swamp vary in texture from a heavy loam to a coarse sand, and no textural or type classification could be made on account of the wet conditions. If drained much of the soil could be classed with types of the Portsmouth series. A considerable part of the Swamp areas consist of a black mucky loam to a depth of several feet, and many of such areas occur along Big Swamp, Raft Swamp, and some of the other large swamps. In a few places muck to a depth of several feet was encountered, this being best developed in Big Raft Swamp. In many places were found areas of sand with black surface soil containing quite a large amount of organic matter, underlain by a white or yellow coarse sand. A few islands or sand dunes are scattered throughout the Swamp in the southern end of the county, and spots and areas of sandy loam were frequently seen. In the area southeast of Rennert, known as the "Desert," the surface soil is a black mucky sand from 1 to 12 inches deep, underlain by a white sand or in some places by sandy clay.

Areas and strips of Swamp occur throughout the county. The largest areas, however, lie along the Big Swamp, on the east side of the county, along Lumber River in the southern part, and at the confluence of these streams, and also between Ashpole Swamp and

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the river on the South Carolina line. Other long strips and areas, varying from one-eighth to three-fourths mile in width, extend nearly across the county. The most prominent of these lie along Shoeheel, Ashpole, Hog, Back, Bear, Indian, Gum, Richland, Little Raft, Big Raft, Gallberry, and Ten Mile Swamps, Big Marsh and Little Marsh, and along Lumber River throughout its course. One body lies just north of Rex, and the desert area is immediately southeast of Rennert. Many very narrow strips occur along the smaller streams and in depressions. Most of the Swamp is of alluvial origin, being composed of materials which have been washed down and deposited by streams. The finer materials were deposited in quiet water, while the coarser sediments and the sand were formed by swift currents. The muck owes its origin to the decay and accumulation of vegetable matter.

Practically all the Swamp has a dense forest growth of cypress, gum, pines, some poplar, ash, and maple, with a thick undergrowth of gallberry, bay, reeds, huckleberry, and other water-loving shrubs. A few junipers were seen in one or two places north of Red Springs. In several localities, especially in the Big Swamp, a large proportion of the cypress has been cut. An immense quantity of valuable timber stands in these swamps.

Portions of the Swamp areas are covered with water the entire year, while other portions are covered during the winter and spring and at times of heavy rainfall. The water table is practically at the surface of those areas not submerged. The water in many of the swamps spreads out into several streams and seems to have no definite channel. A large canal was cut in the Big Swamp several years ago by the lumber company at Boardman and this has aided in a great measure to divert the water to one channel. If the main channels were cleaned out and straightened the water table of these swamps would be lowered and some of the areas would be sufficiently drained for the growing of crops.

In the Big Swamp a small body of the black mucky loam has been drained, cleared, and cultivated. It was planted to corn and the yield was about 50 bushels per acre. Some of the most fertile soil in Robeson County is to be found in the Swamp areas. The black loam areas are well suited to corn, oats, and rice, while the more mucky areas would produce onions, cabbage, and celery in great quantities. Generally speaking, a large part of the Swamp soil, if properly drained, cleared, and devoted to the crops to which it is adapted, would prove valuable farming land.

SANDHILL.

The type mapped as Sandhill consists for the first few inches of a white or light-gray, coarse to medium sand, and continues as a white

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sand or grades into a slightly yellow coarse sand having a depth of 5 to 10 feet. It is loose, porous, and incoherent, containing only a little vegetable matter and a very small percentage of clay. The white surface in a few places has the appearance of drifted snow.

Only a few spots of Sandhill occur in the county, the largest of these being at the southeast end of the Desert, and the others along Lumber River and in the Norfolk sand areas. These knolls and ridges are a few feet higher than the surrounding soil. On account of the coarse texture, small clay content, and very droughty condition, the Sandhill has at present no agricultural value. The material represents an old shore line to the Desert lake and it has been formed along the river by stream and wind action.

The native growth consists of scrub oaks, with here and there a longleaf pine, and bunches of wire grass.

DRAINAGE.

There is no one thing that would benefit the farmers and landowners of Robeson County as much as complete drainage of the soils and particularly the Swamp areas. Some of the most fertile soils in the county which are adapted to corn, oats, rice, cabbage, onions, celery, and other crops remain uncultivated on account of insufficient drainage.

Practically all the level and flat areas of each soil type, except the sands, have to be artificially drained by open ditches of varying width and depth which eventually lead into the natural drainage channels. The open ditches are essential in order to take the surface water from the land. Many of the depressions and bays have been partially drained by ditches, but there are many more such places which it would be rather expensive to drain as the ditches would have to extend a long distance and be cut deep. A great deal of the good land now under cultivation would be greatly improved and would enhance in value if it were better drained.

In order to drain the Swamp areas it will be necessary to clean out, deepen, and straighten the channels so that all the water in one swamp can flow into one channel and then out into other channels until the main outlet to the ocean is reached. Not until the Swamp areas are drained or the water table lowered can many bays be successfully drained. In many places the channels, especially that of Lumber River, could be cut across bends, thus shortening the distance. The larger streams will have to be opened up before the smaller ones can be successfully managed.

When the swamps are drained the upland areas will also be better drained. By better drainage large areas of good land can be reclaimed and the healthfulness of the region improved.

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SUMMARY.

Robeson County is situated in the southern part of the State along the South Carolina line. It is the largest county in the State and contains about 1,058 square miles, or 677,120 acres. The county is favored with ample transportation facilities. It is traversed by the main line of the Atlantic Coast Line Railroad and two of its branches, also by the Wilmington and Charlotte branch of the Seaboard Air Line, the Raleigh and Charleston, the Aberdeen and Rockfish, and the Virginia and Carolina Southern railroads. Fairly good dirt roads are found throughout the county.

There are good local markets for cotton and tobacco. Storage warehouses for cotton have been built in the most important towns, while tobacco warehouses are operated at Lumberton and Fairmont, more than two million pounds of tobacco being annually sold at these two places. Most of the melons and truck crops are shipped to northern markets. Lumberton, the county seat, is the largest town, while Maxton, Red Springs, Rowland, and Fairmont are also important towns.

The population of the county is now about 45,000, and consists of whites, Croatans, and negroes. Each race has separate schools and churches.

The climate is mild, and the rainfall is ample and fairly well distributed through the year. No severe droughts occur. The summers are usually long and hot, while the winters are not very cold. There is a long growing season between the last killing frost in the spring and the first one in the fall. The climate is suitable for diversified farming.

Robeson County ranks first in the State in the production of cotton, producing in 1907 more than 47,000 bales. Bright tobacco is also an important money crop. Large quantities of corn are produced. Watermelons, cantaloupes, sweet potatoes, and truck crops are grown in considerable quantities. Large amounts of commercial fertilizers are used, especially in the growing of the tobacco, cotton, and truck crops.

The farmers throughout the county have been prospering for the last few years. Neatly painted frame dwellings and other improvements are noticeable on the farms. Considerable improved machinery is being used. The surface of the county, together with the character of the soils, permits the use of all kinds of farm machinery. Tenant farming under its several phases is extensively practiced in many sections of the country. The laborers consist chiefly of Croatans and negroes. They usually receive about $15 a month, with board and house to live in, while $1 a day is usually paid when hired for a short time. There are large undeveloped areas of good farming land throughout the county, which could easily be brought under cultivation. Land values have increased in recent years.

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The characteristic surface features of Robeson County vary from broad level and undulating to rolling areas, having a gradual slope from the northwest to the southeast. The natural drainage of the more rolling part is good, while in the level and slightly depressed areas the drainage is assisted by open ditches. The county is well watered by Lumber River and its numerous tributaries.

The soils of Robeson County are derived from the Columbia formation of sand and clays. The weathering of these sands and clays has given rise to two distinct and important soil series, viz, the Norfolk and the Portsmouth.

The Norfolk series represents the lighter colored, better drained soils commonly spoken of as "gray land," while the Portsmouth series are darker in color, contain more organic matter, and are naturally deficient in drainage. The Norfolk soils cover by far the greater part of the county.

The Norfolk sandy loam is the most extensive type, being well developed throughout the northern, central, and western parts of the county. It is a general purpose soil and is easily tilled. It is well suited to bright tobacco, cotton, corn, and the lighter phases to melons, cantaloupes, Scuppernong grapes, and early truck crops. Peanuts would do well on this soil.

The Norfolk fine sandy loam occurs mainly in the eastern and southern parts of the county. Part of it is adapted to tobacco and cotton, and the deeper phase of it to early truck crops and grapes.

The Norfolk very fine sandy loam is a smooth soil, and easily tilled when well plowed and pulverized in the spring. It occurs around Rowland, McDonald, and Raynham.

The Norfolk sand and Norfolk fine sand are loose, porous, and well-drained soils and can be cultivated immediately after a rain. They are suited to grapes, melons, early truck crops, and light farming.

The Portsmouth sandy loam, Portsmouth fine sandy loam, and Portsmouth loam are productive soils. They are adapted to corn, oats, cabbage, and onions. The natural surface drainage is insufficient, and open ditches are necessary in the cultivated areas. Cotton does fairly well on the better drained areas.

The Orangeburg fine sandy loam is a productive soil and is easily tilled. It is suited to tobacco, cotton, and general farming.

The areas of Swamp when well drained, cleared, and brought under cultivation will produce large yields of corn, oats, onions, and cabbage.

The Sandhill is so loose, coarse, open, and droughty that it is practically worthless for agricultural purposes.

The county possesses great possibilities in its soils, and large areas of good land yet remain undeveloped. Much valuable timber is found in the Swamp areas, while considerable merchantable timber remains upon the uplands.

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SOIL SURVEY OF CASWELL COUNTY, NORTH CAROLINA.

By W. EDWARD HEARN, of the U. S. Department of Agriculture, and FRANK P. DRANE, of the North Carolina Department of Agriculture.

DESCRIPTION OF THE AREA.

Caswell County lies in the northern part of the State of North Carolina and about midway from the coast to the western boundary of the State. It is bounded on the north by the Virginia state line; on the east by Person County; on the south by Alamance and a small portion of Orange counties; and on the west by Rockingham County. The county is nearly a square, having a width of about 20 miles north and south and about the same east and west. It contains 256,000

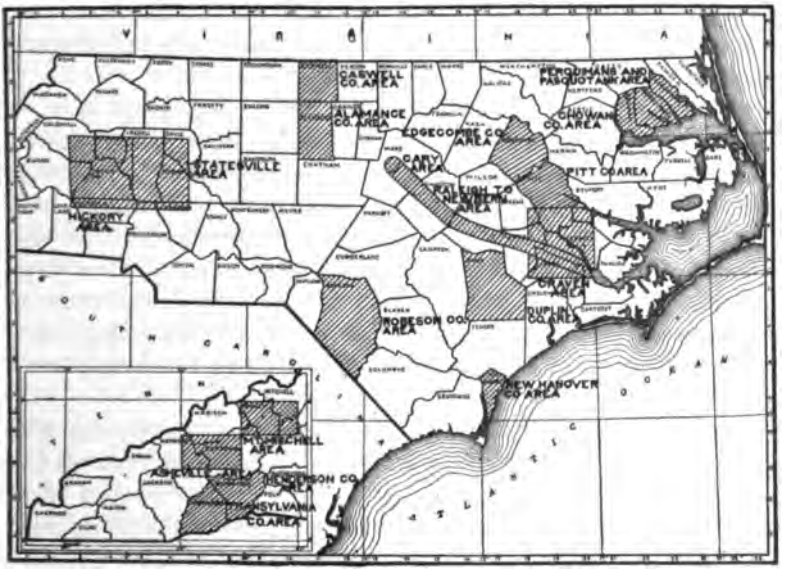

FIG. 7.—Sketch map showing location of the Caswell County area, North Carolina.

acres, or 400 square miles. Yanceyville, the county seat, is located very near the center of the county.

The general slope of all the county is to the northeast and north, except a small section in the extreme southwest corner, which is to the south. The highest elevations are found on the western side of the county, around Ashland and Quick, and along the southern boundary around Jericho, Baynes, Corbetts, Prospect Hill, and Ridgeville, while the lowest elevations occur along Dan River, in the north end of the county.

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The topography consists of a high upland plateau, which has been badly dissected and eroded in many places, thus presenting undulating, rolling, and hilly surface features throughout. Some of the more level and undulating areas occur around Jericho, Baynes, Frogsboro, Semora, Cherry Grove, and Cobbs Shop. There are many large, gently rolling, and rolling interstream areas running in a southwest and northeast direction across the county, which are admirably suited for farming purposes, but which become rolling and hilly as the streams are approached. The roughest areas follow the streams, and perhaps the most rolling and broken bodies of land are developed along Country Line Creek.

Practically all the streams have cut deep, narrow valleys, and bordering these in many places are steep hillsides, which have become badly eroded and gullied. Most of the streams are swift flowing, and on account of the surrounding rolling country the rainfall rushes rapidly into them and they become swollen soon after a heavy rain. Some water power is developed along the creeks and is used in grinding corn and wheat. Considerably more power could be used on these creeks, and a large amount could be developed on the Dan River, near Milton.

Caswell County, on account of its rolling topography, possesses excellent natural surface drainage. The Dan River enters the county on the north and swings around on the northern end, leaving the county at Milton. Hogan, Moon, Rattlesnake, Country Line, and Hyco creeks flow across the county in a northeasterly direction, and all empty into the Dan River, except Hyco Creek, which flows out of the county just south of Semora. Stony and Toms creeks in the southwest corner flow toward the south. The river and these tributary streams and their numerous branches water the county well and furnish the best of drainage.

The area now included in Caswell County was once Orange County. Caswell and Person counties were formerly one county, and Caswell was finally cut off from this area in 1777. Prior to the civil war Caswell County was one of the richest and best in the State, and was one of the three counties to have a bank. It built a court-house in 1858 which would be a credit to any county. Yanceyville, Milton, and Leasburg were flourishing towns, being larger than at the present time. These towns were tobacco markets, and much tobacco was manufactured in them and hauled over the country and sold. Caswell was one of the large slave-holding counties. Most of the citizens in the county are of English and Scotch-Irish descent. There are fewer negroes in the county now than there were slaves before the war. The citizenship of Caswell County has greatly changed since the war, as many of her people moved away, but it is good.

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Most of the population of Caswell County is distributed on the farms. Perhaps the most thickly settled sections are found around Ridgeville, Prospect Hill, Baynes, Ashland, Quick, Locust Hill, Gatewood, Purley, and Estelle. In these localities and also in a few other sections, the farm houses are large and commodious, some being of recent construction, but most of them the fine old antebellum houses. Some of these places have been kept in good repair; many of them have been neglected and present a somewhat dilapidated appearance. Though parts of the county are fairly thickly settled, there yet remain large undeveloped areas, some of which were cultivated before the war and have since been abandoned on account of labor conditions. The county could easily support many times the present population and not be crowded in the least.

The largest towns in the county are Milton, Yanceyville, the county seat, Leasburg, and Pelham, while Semora and Blanch are shipping points on the railroad. Blanch is the nearest station to Yanceyville, it being about 9 miles distant, while Leasburg is about the same distance south of Semora.

The main line of the Southern Railway crosses the northwest corner of the county, while the Norfolk and Danville branch of the same system swings into the northern end of the county, following the valley of the Dan River. Caswell County is somewhat isolated so far as railroad transportation is concerned, and with good railroad facilities through the interior it would develop rapidly. The lands would enhance in value, the towns would become good markets, and business enterprises and manufactories would spring up.

The dirt roads are not kept in as good repair as they should be, and are rough and badly washed in many places. Graded and macadam roads could be built cheaply in all parts of the county, as there is an abundant supply of rock material on hand.

Rural free delivery of mail is in operation in the northern and western parts of the county and in a few other places. Post-offices in other parts are served by the star routes.

Danville, Va., which is located about 3½ miles north of the state line, is the main market for the tobacco produced in Caswell County. A small amount of the tobacco, however, is sold at Milton, and some is carried to Roxboro, Reidsville, and Durham. Most of the produce, such as eggs, chickens, vegetables, potatoes, and beef cattle, is sold in Danville, the remainder being consumed by the small towns in the county.

CLIMATE.

As there is no Weather Bureau station in Caswell County the table giving temperature and precipitation is compiled from the records of the two nearest stations outside of the county. The data, as recorded at Roxboro, 10 miles distant from the eastern boundary, and Reids-

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ville, 11 miles distant from the western boundary of the county, represent fairly well the local climatic conditions. These show a fairly uniform distribution of the rainfall throughout the year. It is heaviest during the growing season and summer months, and lightest during the fall months. There are usually about 12 inches of snow each winter.

Caswell County possesses a healthful climate. The winters are not severely cold, and, owing in part to elevation, the summers are not excessively hot. The spring and fall months are very pleasant. The average date of the last killing frost in the spring is about April 10, and the first in the fall about October 24. This gives a long growing season for the ordinary crops. The amount of rainfall during the growing season greatly influences the quality and yield of the tobacco crop. In a wet season the yield is heavy and the leaf is dark and somewhat stocky, while in a dry season the yield is light in weight, with a bright colored leaf. However, the distribution of the rainfall is such that in most years the quality of the crop is satisfactory.

Normal monthly, seasonal, and annual temperature and precipitation.

Month.	At Roxboro, N. C.							At Reidsville, N. C.	
	Temperature.			Precipitation.					
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year.	Total amount for the wettest year.	Snow, average depth.	Temperature.	Precipitation.
	°F.	°F.	°F.	Inches.	Inches.	Inches.	Inches.	°F.	Inches.
December	40	69	0	3.1	3.1	5.6	3.0	37.4	3.99
January	37	73	0	3.1	2.5	2.2	3.7	33.0	2.44
February	38	71	—7	4.6	5.6	1.1	4.8	37.2	3.80
Winter	38	.....	.....	10.8	11.2	8.9	11.5	.....	.....
March	50	86	11	4.1	4.3	3.8	0.5	48.4	3.27
April	57	91	22	3.7	6.2	6.2	0.2	54.4	3.03
May	67	95	35	5.1	2.6	9.2	0.0	66.7	4.34
Spring	58	.....	.....	12.9	13.1	19.2	0.7	.....	.....
June	74	100	42	3.5	2.0	1.9	0.0	72.1	5.54
July	78	100	52	5.6	6.7	5.7	0.0	75.6	4.12
August	76	100	48	4.0	0.8	11.9	0.0	75.4	4.46
Summer	76	.....	.....	13.1	9.5	19.5	0.0	.....	.....
September	70	100	35	3.8	1.5	5.5	0.0	70.2	2.47
October	58	88	25	3.4	2.7	1.3	0.0	57.8	2.08
November	49	79	13	2.6	2.8	1.7	Trace.	47.3	2.51
Fall	59	.....	.....	9.8	7.0	8.5	Trace.	.....	.....
Year	58	100	—7	46.6	48.8	56.1	12.2	56.3	42.05

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AGRICULTURE.

The early agriculture in Caswell County consisted of growing corn, wheat, and oats as the principal crops, with tobacco as the secondary crop. More cattle, hogs, and sheep were raised than at the present time, and much wool was shorn. Sweet potatoes were grown in considerable quantities and rye, flax, peas, beans, and hay were produced to a small extent. Larger yields of grain were secured then than now, partly because the land was new and partly because larger quantities of barnyard manure were made and applied to the land. Moreover, subsoiling and deep plowing were practiced to some extent, and these aided in securing the good results. It was naturally a good grass and clover region, and these furnished excellent pasturage. Land values were high. All the home supplies were produced on the farm. The wool and cotton were manufactured into clothing. A dark, heavy-leaf tobacco was produced, the yield being as high as 1,500 pounds per acre. The tobacco was at first sold in Petersburg, Va., and at other outside points, and later at Milton, Yanceyville, and Leasburg. Its production increased until it became one of the main crops with corn, oats, and wheat, while cotton, potatoes, and rye were crops of less importance. The production of crops, except cotton, gradually increased till 1860. Land greatly increased in value between 1850 and 1860 and many improvements and advancements were made. This was the most prosperous era in the history of Caswell County; there was more land under cultivation and better methods of cultivation were practiced than at any previous time. Many fine country homes were built and the financial standing of the county was the best of any county in North Carolina.

Then came the war, with its disastrous effect upon economic conditions. The freeing of the large number of slaves could not but disorganize, temporarily at least, the agriculture of the country. Many of the large plantations were partly abandoned and some of the land has not yet been entirely reclaimed. Immediately following the war the production of grain crops decreased and tobacco began to be more extensively grown as a money crop. Cotton finally ceased to be grown, although there are certain varieties which could be produced here to advantage.

At the present time bright-yellow tobacco is the most important crop grown in Caswell County. It is the money crop, and practically all business depends upon it. The crop next in importance is corn, which is grown in all parts of the county. Considerable wheat and oats are produced. Some cowpeas, clover, sweet potatoes, and all kinds of vegetables are also grown. Patches of sorghum cane are grown and sirup is manufactured for home use. Only a few cattle, sheep, and hogs are raised. There is a small output of fruit, mainly

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apples, peaches, and pears. In many sections of the county are found considerable areas of white, post, and red oaks, hickory, some yellow pine, poplar, persimmon, and scattering trees of other varieties, which will make valuable timber. Many hoops are made from the white oak and sold in Danville for use in packing tobacco. Many of these hardwoods could be profitably manufactured into spokes, handles, and other useful articles, as well as furnishing splendid material for furniture manufactories.

It is recognized by the best farmers that not all the soils in the county are equally suited to all crops. It is generally believed that the Durham coarse sandy loam is the best soil for the production of bright tobacco, this soil being its original home. While tobacco is grown on all of the upland soils, it is well understood that only certain spots of Iredell sandy loam, much of the Caswell sandy loam, and large areas of Cecil sandy loam are well suited to the growing of a good grade of tobacco. The red lands, such as Cecil clay and heavy areas of Cecil sandy loam, are best adapted to corn, wheat, oats, clover, grasses, and cowpeas. The Iredell sandy loam should be seeded to grass or to oats. The Congaree loam, a river-bottom type, is an ideal corn soil.

No regular rotation of crops is practiced throughout the county. Some of the best farmers, however, plant corn one year, grain the next year, then rest the land one year and plant to tobacco. Some rotate wheat with tobacco, and occasionally corn is planted to use up the excess nitrogen remaining after the tobacco crop. Others plant corn, rye, and then tobacco. Tobacco does well on land where rye has been turned under. It is claimed by many that tobacco does not do well immediately following cowpeas, as there seems to be too much humus in the soil. Tobacco does well when following a crop of oats; and a practical rotation would be corn, sowing cowpeas at last plowing, oats, and then tobacco.

The methods of handling the tobacco seem to be fairly well suited to the present conditions. The whole stalk is cut in the field and hung in the barn for curing. The practice of stripping the leaves from the stalk as they ripen has not met with favor here.

The lands devoted to corn and grain crops are not in most cases plowed deep enough nor sufficiently pulverized prior to the planting or sowing of seed. A few farmers sow cowpeas at the last plowing of corn and some sow them after oats and wheat, thus making excellent hay and at the same time improving the soil.

Farm labor can be secured at from $10 to $18 a month by the year, with board, tenant house, and garden patch. The highest prices are paid near the towns and railroads. It is generally scarce, however, at any price, because of the fact that nearly all of the laboring class

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would rather rent land on the share basis than work for wages. In this way the laborer can do more nearly as he desires and is not confined so closely.

While a great many of the farms, especially the smaller ones, are operated directly by the owners, the larger number are rented on a share basis; that is, for a certain part of the crops produced or a stated amount of rent. If the landowner furnishes only the land, he receives one-fourth of the crop, and in some sections he also has to pay one-fourth of the fertilizer bill. If he furnishes the land, stock, implements, and one-half of the fertilizer, he receives as his part one-half of all the crops produced.

The farms in many cases are not as large as they were formerly. There still remain a few of the large plantations here and there, but most of them have been subdivided and the farms now range in size from 100 to 500 acres. In the southeastern part of the county they vary in size from 300 to 500 acres and around Yanceyville from 150 to 300, while in the vicinity of Cobbs Shop the ordinary size is about 100 acres. In other sections there are some farms as small as 50 acres.

There is much land in Caswell County that can be bought for $7 to $15 an acre. Immediately south of County Line Creek farms may be purchased at prices ranging from $4 to $7 an acre. Some improved lands with large buildings, located near Yanceyville, Milton, and Blackwells, are held at $7 to $20 an acre. The highest priced land is in the southeast corner of the county. On a basis of actual productiveness, land values are very low at the present time.

All of the heavier soils, especially the Cecil clay and the heavier portions of the Cecil sandy loam, should be plowed deeper, subsoiled, and better prepared before the crops are planted. There should be a greater diversity of crops. More corn, oats, wheat, clover, grass, and cowpeas should be grown. The soils are well adapted to these crops, and they can be produced with profit. Red clover should be seeded on the hillsides. This would make excellent hay, give good pasture, and prevent the land from washing. Caswell County should produce more of all the crops than is needed for home consumption and should be an export county of other products besides tobacco. More hogs and cattle could be raised cheaply, if more grain and hay were produced. The growing of cowpea vines for hay should be more generally practiced, as these would furnish the needed feed for stock and at the same time supply the soil with humus and nitrogen for succeeding crops, thus avoiding the necessity of buying so much fertilizer.

The rolling, broken, and hilly areas should be seeded to grass with a mixture of 10 pounds of orchard grass, 5 pounds of redtop, and 5

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pounds of Canadian bluegrass to the acre and annually dressed with bone meal. This seeding will make excellent pastures and cattle raising could be profitably carried on upon areas not as well adapted to other uses. The raising of spring lambs in this dry, high country would pay handsomely, as the lambs could be put on the market in the early spring, at which time they sell for fancy prices. Near the railroads, where the transportation facilities are good, dairying would be profitable, and also poultry raising and the growing of truck crops, apples, peaches, pears, cherries, and grapes.

TOBACCO.

The tobacco industry and its development constitute one of the most important chapters connected with the agriculture of Caswell County. Tobacco has been grown in this county since about 1793, and its production has gradually increased. In 1840 there were more than 3½ million pounds grown in the county, while in 1860 the production reached more than 4½ million pounds. It was about 1850 that tobacco became of considerable importance in North Carolina. The first tobacco raised, and even up to 1852, was a dark, heavy tobacco which was cured in open air and shade, closely packed in barrels or hogsheads, and hauled to distant markets, mostly to Petersburg, Va., some being carried to Fayetteville, N. C., and other markets.

Before the war a large amount of tobacco was manufactured at Yanceyville, Milton, and Leasburg, and hauled in wagons over the South and sold. Much of this tobacco was cultivated on the Cecil sandy loam, Cecil clay, and Caswell sandy loam. Larger yields per acre were secured then than now, and occasionally 1,500 pounds to the acre was produced. The tobacco had a thick, heavy leaf and was dark in color.

In 1852 bright yellow or lemon leaf tobacco was grown for the first time in Caswell County by Eli and Elisha Slade. Its peculiarities were attributed particularly to the methods of curing it by artificial heat, which had not been used prior to this time. This method of curing gave a brighter colored and a sweeter and more attractive leaf. This type of tobacco at once became popular in the foreign as well as home markets. It increased the consumption of tobacco and displaced, to a large extent, the darker types. The immediate effect of the introduction and the popularity of this new leaf, used for plug filler and wrapper, was to send land values in this region high and the poor, sandy soils, which had been considered practically worthless for general farming, were found to be peculiarly adapted to this grade of tobacco. The bright tobacco at first sold for fancy prices—much higher than at the present time—and the great demand, coupled with high prices, caused the extension of its cultivation to the sandy soils throughout the county, especially to the Durham coarse sandy loam,

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upon which good farm houses and barns were built. The great increase in its production in this and other regions, combined with other conditions, later caused a decided decline in prices.

Immediately after the war Danville, Va., became the main market for the tobacco grown in Caswell County and the adjoining region in North Carolina and Virginia, and it is to-day the largest loose-leaf tobacco market in the world. According to the best information, Caswell County produces more than 6,000,000 pounds of tobacco annually.

Bright tobacco is used principally for pipe smoking, for cigarettes, and for plug wrappers and fillers, and a large amount is exported. Warren and Gooch are the main varieties grown on all the upland soils. Some Orinoco is also produced; it is said to give a smaller and more uniform leaf. Topping considerably influences the grade; low topping gives a darker and heavier leaf, while high topping gives a lighter leaf.

In growing bright tobacco, about 5,000 plants are set to the acre, and practically all of the setting or transplanting is done by hand, though on the more level areas tobacco transplanters could be used advantageously, thus saving much hard labor.

The tobacco is grown to a greater or less extent on all the upland soils in the county, but more extensively on the Durham coarse sandy loam and Cecil sandy loam. While there is some difference in the yields, there is a great difference in the quality of the leaf produced on the various soils and in the resulting price. An expert tobacco man can usually tell from what section of the county the tobacco came and upon what soil type it was grown. The Durham coarse sandy loam produces the best tobacco. It grades as bright wrappers and cutters, and usually has good body. The yields range from 500 to 1,000 pounds per acre, and the price from 10 to 40 cents a pound, averaging near 14 cents. The Cecil sandy loam produces an orange-colored waxy tobacco; sweet fillers and some wrappers are produced around Milton and Estelle; some wrappers and fillers in the vicinity of Blanch, Covingtons Store, and Locust Hill; and some bright mahogany wrappers in the Pelham section. The best wrappers bring as high as 30 cents a pound, and the lower grades from 6 cents up, the average for the type being about 10 cents. The yields on this soil type range from 700 to 1,200 pounds per acre.

The Caswell sandy loam produces in a dry season a bright light leaf and in a wet season a darker leaf, grading as wrappers and fillers, which sell on an average at about 11 cents a pound. The yield is from 600 to 800 pounds per acre. The Iredell sandy loam produces a rather coarse red tobacco—some wrappers, but mostly fillers—which sells at 9 or 10 cents a pound. The yield is from 700 to 800 pounds per acre. The Cecil clay produces 800 to 1,000 pounds per acre of a red to black mahogany leaf which is heavy and waxy.

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SOILS.

Caswell County lies wholly within the Piedmont Plateau section of the State. The soils, with the exception of small areas of alluvial deposits along the streams, are of residual origin, being derived in situ from the underlying rocks of the region. The rocks of the northwestern and northern parts of the county are principally gneiss, granite, and other igneous and metamorphic rocks. They are composed largely of gneisses and schists of the mica types, with occasional dikes of diorite and other rocks. Watson terms this belt of rock the "western Piedmont gneiss and granite belt." The rocks of the southern and southeastern parts of the county are mainly granite and diorite, with some other rocks of igneous origin. These rocks are frequently cut by dikes of basic igneous rock, such as diabase, and quartz veins are common. This belt of rock is called the Carolina igneous belt (the main granite belt).

The gneiss, schist, and in many places the granite have weathered to a considerable depth, and give rise to the Cecil clay, Cecil sandy loam, and Durham coarse sandy loam. The diorite from which the Iredell sandy loam is derived has not weathered so deeply and the disintegrated rock is seldom more than 30 inches below the surface. The Caswell sandy loam, though derived from the gneiss, schist, and granite, has been formed in a large measure by excessive erosion. The Herndon stony loam is a residual soil from quartzite. The Congaree loam is of alluvial origin, being formed by the deposition of material by the river, while the strips of Meadow are alluvial and colluvial deposits.

The Cecil sandy loam and Cecil clay are typical of the gray and red soils of the Cecil series throughout central North Carolina and the Piedmont Plateau, which extends from New Jersey to western Alabama. The Durham coarse sandy loam and Iredell sandy loam are associated types of the Cecil series. On account of the various rocks, their complicated arrangement, and the topography of the country, the soils in many places are badly mixed up and change from type to type so frequently and yet so gradually that it was often difficult to draw an exact boundary line between them.

The following table gives the names and extent of the several soil types mapped in the county:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Cecil sandy loam	99,200	38.8	Meadow	13,632	5.3
Iredell sandy loam	57,792	22.6	Congaree loam	3,712	1.4
Caswell sandy loam	38,912	15.2	Herndon stony loam	384	.1
Durham coarse sandy loam	27,328	10.7			
Cecil clay	15,040	5.9	Total	256,000	.....

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CECIL SANDY LOAM.

The surface soil of the Cecil sandy loam consists of a gray, yellowish-gray, or brown medium sandy loam ranging in depth from 5 to 15 inches. In the vicinity of Semora the soil in local areas is a fine sandy loam, and around Pelham and along the Southern Railway and to the southwest a fine sandy loam from 10 to 15 inches deep is encountered. Just south of Yanceyville, across Country Line Creek, areas of this soil are intermingled with areas of the Iredell sandy loam and the Caswell sandy loam. Throughout all areas of the Cecil sandy loam there are found spots of loam or clay loam where the surface soil has in part been washed off. These spots are usually brown or reddish in color. There are a few quartz gravel in many areas of the type, and in spots here and there quartz fragments in large quantity are seen. Such spots are called flinty knolls or ridges. This soil type is mellow, easily tilled, and if plowed under proper conditions of moisture breaks up into a loose, mellow tilth.

The subsoil to a depth of 36 inches and more is a stiff, red clay, being tough and hard when dry and sticky when wet. In some few areas, especially around Blackwells and Quick, it is reddish-yellow or mottled in color, and occasionally some angular quartz and veins of quartz are found in it.

The Cecil sandy loam is the most extensive and most important type of soil for general farming purposes in Caswell County. It covers practically all of the western side of the county and extends across the county from the southwestern corner to the northeastern side, embracing most of the northern end of the county. It is frequently broken, however, by areas of Caswell sandy loam and spots of Cecil clay in the central and northeastern parts. The type is well developed around Semora, Estelle, Purley, Gatewood, Pelham, Quick, Ashland, Locust Hill, Yanceyville, and Hamer. Isolated bodies lie south of Country Line Creek and small spots occur in the southeastern part of the county in the Durham coarse sandy loam.

The general surface features of this type vary from level and undulating to rolling and broken. Some of the more level and gently rolling areas occur in the vicinity of Semora, Estelle, Locust Hill, Ashland, Pelham, and north of Yanceyville. The roughest areas are found near the streams, especially along Country Line Creek and some of the other large streams, and in these sections the hillsides are usually steep and in many cases deeply gullied. Erosion is and has been very active on the hillsides since the forests have been cut. On the other hand, much of the Cecil sandy loam lies beautifully for general farming purposes, as many of the interstream areas are gently rolling, becoming hilly and broken only as the streams are approached. This type, owing to its topographic features and to the open texture of the surface soil, possesses good nat-

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ural surface drainage. On some of the hillsides terraces have been constructed with the contour of the land which prevent washing and gullying to a considerable extent.

The Cecil sandy loam has been derived from the weathering of gneisses, schists, granites, and other igneous rocks. These are largely of the mica class, and this fact accounts for the presence of small scales of mica in both the soil and subsoil in many places. These rocks have weathered to a depth of several feet.

The original forest growth upon this soil consists of white, post, red, and chestnut oaks, hickory, some yellow pine, and a little dogwood, sourwood, persimmon, cedar, and cedar pine; while the second growth consists of cedar pine and old field pine, which have grown up on areas abandoned for farming purposes.

The Cecil sandy loam is an important type of soil throughout the Piedmont Plateau and is one which is adapted to a wide range of crops. The medium, loose-textured soil is well adapted to bright tobacco, sweet potatoes, and truck crops. The heavier and more loamy areas are especially suited to corn, wheat, oats, clover, and grasses.

Tobacco yields from 700 to 1,200 pounds per acre, corn from 15 to 20 bushels, wheat about 12 bushels, oats 20 to 30 bushels. Clover yields well, but it is said to be a little difficult to get a stand of this crop. In many cases this can be overcome, however, by better preparation of the seed bed. Sweet potatoes make excellent yields, while Irish potatoes, garden vegetables, peaches, apples, and grapes do well. By good preparation, cultivation, rotation, and by the use of coarse manures and a fair application of commercial fertilizer as high as 30 bushels of wheat and 50 bushels of corn per acre have been produced. These yields show what can be done with the soil by proper treatment for a few years.

The Cecil sandy loam should be plowed a little deeper each year until a fine, pulverulent seed bed with a depth of 8 to 10 inches is secured. This deep plowing would prevent to a great extent considerable washing on the rolling areas. Cowpeas do well on this soil, and by plowing under the vines the soil would be greatly benefited, as these would increase the supply of humus, which has been in a large measure depleted through continued cultivation, and at the same time add needed nitrogen. Clover would also improve the soil and be an excellent crop in rotation with wheat and corn. Lime used in connection with the green cowpea vines would likely show greatly increased yields in the crops. Phosphoric acid has been found to give increased yields when used on land which was thoroughly prepared and which contained large amounts of humus. The hillsides and roughest areas of this soil type should be seeded and used as grazing

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lands or allowed to remain forested. Cattle raising could be made a profitable industry on this type in connection with the growing of forage crops.

Upon the Cecil sandy loam are applied large amounts of commercial fertilizers of 8–3–3 and 8–2–2 grades, and some other grades to a limited extent. Tobacco is heavily fertilized with from 400 to 800 pounds per acre. The corn and wheat crops are also fertilized, but lightly as compared with the tobacco.

The best farms of this type, improved with large houses, sell at $10 to $20 an acre, while much of the type can be bought at $7 to $10 an acre.

The average results of mechanical analyses of soil and subsoil of this type are given in the following table:

Mechanical analyses of Cecil sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19937, 19939.....	Soil.....	5.3	16.7	10.2	24.2	11.2	23.6	8.5
19938, 19940.....	Subsoil.....	2.5	7.0	5.3	15.7	7.0	19.3	43.2

CECIL CLAY.

The surface soil of the Cecil clay consists of a reddish or light-brown clay loam or loam to a depth of 6 inches. In a few places a heavy sandy loam to a depth of 1 to 3 inches overlies the clay loam. There are a few quartz gravel in some areas and occasionally quartz fragments are seen on the surface. The subsoil to a depth of 36 inches and more is a stiff bright red clay. A few spots of reddish-yellow clay are encountered. These are a little more friable than the typical red clay subsoil.

This soil type occurs in areas and spots scattered throughout the greater part of the county. The largest area, however, lies in the southwestern part of the county around Milesville and Cherry Grove, and other rather large bodies were mapped near Dan River, Milton, and on the county line west of Pelham.

Most of the surface is rolling, becoming hilly and broken near the streams. Some of the spots and the highest elevations in the large areas are gently rolling to level. The more rolling areas which have once been cultivated are in many instances badly gullied. Practically all of the type possesses good natural surface drainage.

The Cecil clay is derived from a very complete weathering of gneiss, schist, and granite, giving a very fine-textured, stiff soil. These rocks have disintegrated and decomposed to a great depth in many places, as seen in gullies and road cuts.

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The greater part of the Cecil clay is forested with the original growth of white, red, and post oaks, some yellow pine, poplar, and hickory. All of these are valuable as merchantable timber. A few areas which were cultivated before the war are now forested to a second growth of old field pine and *Pinus virginia*, locally called "cedar pine."

The Cecil clay is well adapted to corn, wheat, oats, cowpeas, clover, and grasses. Clover and orchard grass would yield well and would be an excellent crop to prevent the knolls and slopes from washing. Corn yields from 15 to 35 bushels per acre; oats, wheat, and cowpeas do well. Tobacco produces from 800 to 1,000 pounds per acre. The leaf is somewhat coarse and heavy and it cures to a red or black mahogany color, selling at a lower price per pound than the tobacco grown upon the sandy loams. The Cecil clay is naturally one of the strongest soils in this region and is susceptible of high improvement. The effects of manures are quite lasting. The yields upon this soil can be greatly increased by deeper plowing, more thorough cultivation, and by growing cowpeas and clovers to fill the soil with humus. Lime would be beneficial following the use of green crops. Acid phosphate applied to this soil will, in connection with the above treatment, increase the crop yields, and probably serve in a great measure the same purpose as a cheap complete fertilizer. The soil can be made to produce much larger yields than it does at present.

This land is now selling at from $5 to $10 an acre.

The results of mechanical analyses of the soil and subsoil of the Cecil clay are given in the following table:

Mechanical analyses of Cecil clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19933	Soil	0.8	3.2	1.6	14.8	21.8	37.5	20.2
19934	Subsoil	.0	.6	.7	9.4	9.9	33.3	46.2

HERNDON STONY LOAM.

The Herndon stony loam to a depth of about 6 inches is a yellowish or grayish fine sandy loam containing from 40 to 60 per cent of rock fragments of quartzite and schist and small gravel. The slopes near the base of the mountain are not so stony as the higher elevations. The subsoil is a yellow fine sandy clay, which at a depth of 15 or 20 inches passes into a yellow or mottled clay. A few iron gravel are present in the subsoil, and in a few places disintegrated rock is encountered at 24 inches.

There is only one body of this soil in the county, and it covers a little more than 1 square mile in the southwest part on the Caswell

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and Alamance county line. It occupies the northern end of Stony Creek Mountain, which rises some 100 to 200 feet above the surrounding country. The slopes of this mountain are gentle and regular, there being no large gullies or any great amount of erosion, and the natural surface drainage is good.

This soil is derived mainly from the weathering of quartzite, being modified to a certain extent by the presence of coarse-textured diorite and schist.

Practically all of the mountain is forested. On the sides there are white, red, and chestnut oaks and yellow poplar, all of which is valuable as merchantable timber, while near the top the trees are smaller and some scrub oaks were seen. This soil will produce good fruits, especially peaches and apples. Where cultivated near the base of the mountain, corn and tobacco were grown. A fair yield of corn is usually obtained.

This land is held at from $4 to $6 an acre.

The results of mechanical analyses of soil and subsoil are given in the following table:

Mechanical analyses of Herndon stony loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19935	Soil	3.5	7.0	3.2	15.0	25.9	38.7	6.5
19936	Subsoil	2.2	2.9	2.2	19.6	20.1	26.7	25.8

IREDELL SANDY LOAM.

The surface soil of the Iredell sandy loam consists of a dark-gray or dull-brown medium to fine sandy loam, to a depth of 6 to 10 inches. The land is commonly called "black-jack oak," or "beeswax" land. On many of the knolls and ridges, except where the surface has been eroded, the soil is a loose, medium, sandy loam, while on the flat and level areas a fine sandy loam or mellow loam is encountered. A few small iron concretions are of frequent occurrence in this soil. Just north of Stony Creek Mountain there is a large amount of these concretions, and the soil is open and gravelly to a depth of 12 to 14 inches and produces good crops.

The subsoil is a yellowish, light-brown, or dull-brown, sticky, impervious clay, usually about 30 inches deep, and there are spots where the subsoil is a reddish, sticky, heavy clay. Only in a few areas does the subsoil extend to a depth of 36 inches. Throughout the greater part of the type the clay subsoil grades into a soft, disintegrated diorite rock at 24 to 30 inches, and this passes into the hard bed rock at about 36 inches. The yellow clay on exposure to the weather

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becomes dull brown in color. It cracks open upon drying, and is very plastic and sticky when wet. In the vicinity of Prospect Hill the soil is somewhat coarser in texture than in the main areas of the type, and the subsoil is somewhat mottled and contains a few quartz particles. In some of the poorly drained areas a thin iron crust, locally known as hardpan, is found between the soil and subsoil.

A great part of this type occurs in one large area in the southeastern part of the county, beginning at the south side of the county at Stony Creek and extending in a northeasterly direction across the county, varying in width from 4 to 6 miles. It has a very irregular northern boundary, but a rather regular and undulating southern boundary adjoining the Durham coarse sandy loam. This soil type is typically developed around Leasburg, Hightowers, Topnot, Fitch, and Jericho, and one body of the coarser and deeper phase is found in the vicinity of Prospect Hill. A few spots and bodies are scattered over the northern and central parts of the county.

The topography of the Iredell sandy loam varies from level and gently rolling to rolling and badly broken areas. Some of the flat, level, and gently rolling areas lie between Frogsboro and Leasburg, Baynes, and around Jericho. The more rolling, broken, and hilly areas occur along the county line and Hyco and Reedy Fork creeks. Especially is this topography noticeable in traveling from Leasburg to Topnot. A considerable part of this rolling country is badly eroded. All the rolling areas have good natural surface drainage, but the flat areas are poorly drained. The impervious subsoil retards the downward movement of the rain water and also hinders the capillary movement of the soil moisture.

The Iredell sandy loam is derived mainly from the weathering of diorite, which is a dark-green rock; the differences in the amount of quartz and feldspar in this rock affect the soil to a more or less degree. The diorite is cut by veins of granite and gneiss and hornblende. In the granitic areas, especially in the Prospect Hill section, the soil appears to be derived from this granite. The more sandy areas of the type are derived from the diorite, which contains a large amount of quartz, and from the granite and gneiss veins. The weathering of the diorite and its associated rocks has not been deep. This is perhaps due in a large measure to the impervious nature of the subsoil.

The native growth on this type consists of post, red, white, and black-jack oaks, and a few cedar pine. Some excellent timber was seen on this type between Leasburg and Frogsboro and in many other places.

On spots on the high sandy ridges and knolls, which are well drained, tobacco does fairly well, but the type as a whole is too cold natured and the subsoil too impervious for the successful production of this crop. It is best suited to oats, wheat, grasses, and corn.

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Oats would probably be the best crop to grow upon this soil. The cattle industry should be developed on this type.

Corn yields from 10 to 20 bushels, and sometimes as much as 35 bushels per acre; wheat, from 7 to 10 bushels on an average, but as high as 27 bushels have been produced near Stony Creek by some of the best farmers; oats, 20 to 30 bushels on an average, with a maximum yield of about 50 bushels; tobacco, about 700 to 800 pounds, the leaf being somewhat coarse and stocky and having little body.

By better drainage, aeration, deeper plowing, and by the use of lime this soil can be improved. It is naturally acid in character, and this acidity needs to be corrected in order for it to produce its maximum crops. The usual brands of fertilizer are used. Barnyard manure warms and loosens up the soil, thus greatly increasing the yields. Large areas of this type are at present undeveloped, being covered by a growth of black-jack oak and the merchantable timber previously mentioned.

Much of this land, unimproved, can be purchased at $5 an acre, while the best improved land nearest the lines of transportation sells at from $10 to $12 an acre. It is not so desirable a soil as the Cecil sandy loam.

The following table gives the average results of mechanical analyses of soil and subsoil of this type:

Mechanical analyses of Iredell sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19949, 19951.....	Soil.....	3.4	8.7	7.8	27.5	15.7	30.1	6.9
19950, 19952.....	Subsoil.....	.1	1.5	1.7	7.1	9.2	22.4	58.1

DURHAM COARSE SANDY LOAM.

The surface soil of the Durham coarse sandy loam to a depth of 8 to 15 inches consists of a yellowish-gray to gray coarse sandy loam. It is commonly called "gray land" or "isinglass land." In the forested areas the first few inches of the soil is of dark-gray color, due to the presence of organic matter. Most of the type contains a few fine quartz gravel. There are some bodies of medium sandy loam, and these are usually free from gravel. The coarser areas of the type are noticeable around Ridgeville and Baynes. In many localities there is a small amount of finely divided mica in the soil and also in the subsoil. It is a loose, open, easily tilled soil, warming up early in the spring. Throughout the type there are strips and spots of soil very similar to the Iredell sandy loam, and in some places it was difficult to draw a boundary line between these two types.

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The subsoil of the typical areas is a yellow friable clay, with some coarse sand particles, to a depth of 36 inches. In small areas the subsoil is a reddish-yellow or mottled yellow clay, while adjoining the Cecil sandy loam areas the subsoil grades into a red clay. Occasionally there are dikes of granitic rock which have not been weathered so thoroughly as the true granite, and this disintegrated rock is encountered at from 20 to 30 inches, and sometimes the surface soil grades into it.

The development of this type is confined exclusively to one large irregularly outlined area in the southeastern part of the county. It is broken only by small strips and spots of other types. It is typically developed around Ridgeville, Corbetts, and Baynes, and borders the Alamance and Orange County line 14 miles on the south and the Person County line for 6 miles on the east, thus giving a large triangular-shaped area of soil.

The surface features of this type vary from rolling and broken areas to gently rolling and level areas. The ridge from Frogsboro to Ridgeville by Prospect Hill and the section around Corbetts and Baynes are the largest and most typical areas of gently rolling to level topography. The more rolling and broken areas occur along Hyco, Lynch, and Sugar Tree creeks. The hillsides are sometimes steep and in many cases erosion is excessive. The open texture of the surface soil, coupled with the rolling topography, insures excellent natural surface drainage, and practically no areas of any extent require underdrainage.

The Durham coarse sandy loam is a residual soil which has been derived from the weathering of a granite rock, being influenced in restricted areas by dikes of diorite, diabase, and small veins of quartz. The granite rock is a coarse-grained biotite granite which is composed of feldspar, quartz, and mica. It is usually decomposed to a depth of several feet, but in some cases a disintegrated rock comes near the surface. The feldspar breaks down, forming clay, while the quartz remains as sand, and the resultant product is a loose, coarse-textured sandy loam with a few mica scales.

The larger part of this type is under cultivation, while the remaining areas are forested to white, post, and red oak, some hickory, dogwood, and other hardwoods, and scattering yellow pine. Some of this forest contains valuable timber. This soil is particularly adapted to bright yellow tobacco, for which it is the best soil in this section of the State. It is also suited to sweet potatoes, fruits, and truck crops, and by a rotation of crops, proper cultivation, and manuring, it will produce fairly good yields of corn, wheat, and oats. Tobacco yields from 500 to 1,000 pounds per acre, the average being about 700 pounds; corn, from 10 to 20 bushels; and wheat, 7 to 10

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bushels. Sweet potatoes do well, and apples, peaches, small fruits, and garden vegetables give very satisfactory returns.

There is a custom of fallowing land, allowing it to grow up to broom sedge for one or two years, then planting it to tobacco. Tobacco does well on land treated in this manner. It has been found that tobacco following cowpeas produces a somewhat inferior grade the first year, but by planting corn after the cowpeas for one year the soil is brought into good condition for tobacco. Coarse stable manure and cowpea vines incorporated in the soil considerably increase the yield, and the effects of such treatment are seen in the soil for several years.

Practically all the crops grown upon the Durham coarse sandy loam are fertilized to a more or less extent, especially tobacco. About 600 to 900 pounds of a complete fertilizer, analyzing nitrogen 3, phosphoric acid 8, potash 3 per cent, is used. Some use the 8–2–2 grade considerably. A few farmers apply about 50 pounds of nitrate of soda at the second working of tobacco. Tenants, as a rule, do not use quite as large quantities of fertilizer as the farmer who cultivates his own field. Stable manure does well for tobacco, but the tobacco does not seem to ripen just right with the manure alone, so some commercial fertilizer is required in order to get a good grade of tobacco.

Part of the Durham coarse sandy loam is in a low state of cultivation, due to the clean and yearly cropping of the soil to tobacco. The undeveloped areas of this soil sell for $8 to $15 an acre, while the better improved areas around Baynes and Ridgeville are held at $10 to $40 an acre.

The average results of mechanical analyses of the soil and subsoil of this type are given in the following table:

Mechanical analyses of Durham coarse sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19945, 19947.....	Soil.....	14.4	25.2	9.3	14.6	9.9	20.9	5.0
19946, 19948.....	Subsoil.....	5.4	10.8	5.4	8.6	3.4	26.7	39.7

CASWELL SANDY LOAM.

The surface soil of this type, to a depth of 6 to 10 inches, is a light-gray, yellowish-gray, or ashy colored medium sandy loam, usually containing a few fine fragments of gneiss and quartz. In many places there are spots of Cecil sandy loam and spots and strips of Iredell sandy loam and phases of these types scattered throughout areas of the Caswell sandy loam.

The subsoil of the best-developed areas is a yellow sandy clay with spots of mottled or reddish clay. The subsoil commonly grades into

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disintegrated gneiss or granite at 24 to 30 inches, and in many instances on the steeper slopes this decayed rock joins the surface soil and even outcrops occasionally. There are some areas where the sandy clay subsoil passes into an impervious brown, mottled yellow or gray clay just before the partially decomposed rock is reached. This impervious stratum considerably influences the drainage, and such spots are cold natured and sour.

The Caswell sandy loam occurs in large areas of irregular outlines in the central and northeastern parts of the county. Large areas are found along Country Line, Hyco, Moon, Hogan, and Rattlesnake creeks, being well developed around Yarbro, Yanceyville, and south of Blanch. Small bodies are distributed throughout the Cecil sandy loam areas.

The type occupies the roughest topography in the county, it being hilly, rolling, and rough, following the streams, and lying between the rolling uplands of the Cecil sandy loam and the alluvial deposits along the stream. The surface features of some of the knolls and ridges are favorable for cultivation, but there are bodies of this soil which are so broken and rough as to preclude their use for general farming purposes. The small streams and rivulets have made deep inroads into this type, leaving steep hillsides which are in many cases badly gullied. Owing to its position, it possesses the best natural surface drainage of any type in the county. In many cases the drainage is too excessive, as those bodies which have the decayed rock or bed rock near the surface are loose, porous, and quite dry. The only poorly drained spots are where the impervious clay occurs in the subsoil.

Most of this type is derived from the disintegration and decomposition of gneiss and schist, and some from granite. There are dikes of diorite throughout these formations which have influenced the soil to some extent. This soil in the main is derived from the same kind of rock as the Cecil sandy loam, but erosion, on account of the topography, has so acted on the material as to give a soil entirely different in composition and agricultural value. The Caswell sandy loam might rightly be termed a product of excessive erosion. On account of the rolling and hilly surface, erosion has kept such a close pace with the disintegration and decomposition of the rock that the accumulation of the soil has not been deep. The rain water carries away in suspension the finer particles, leaving the coarser ones, thus giving a loose sandy loam soil.

The native growth consists of oak and other hardwood, yellow pine, some cedar pine, and old field pine. The more uniform areas on the ridges and knolls are adapted to bright tobacco. Truck crops, berries, potatoes, and vegetables do well. Clover gives good yields upon this soil and should be grown more extensively. Tobacco at present is the

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main crop and yields from 600 to 800 pounds per acre. Corn, wheat, and oats give low yields ordinarily, but when the soil has been manured and properly cultivated good yields are secured. Some cowpeas are grown. The Caswell sandy loam produces its best crops during the rainy season.

Green cowpea vines and coarse manures would improve this soil considerably. The ordinary 8–3–3 and 8–2–2 fertilizer is commonly used on this soil. A great deal of the soil seems to be practically depleted of its humus, and the cowpea vines, clovers, and manures would supply the needed humus and furnish nitrogen for the crops. The roughest and most badly gullied areas of the Caswell sandy loam should be reforested or remain forested. The other broken areas could be used advantageously for pasture land. The seeding of these rolling areas would prevent washing and excessive erosion.

Land of this type ranges in price from $3 to $10 an acre, depending on its location and the topography.

The following table gives the average results of mechanical analyses of the soil and subsoil of the Caswell sandy loam:

Mechanical analyses of Caswell sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19929, 19931	Soil	3.3	13.2	11.7	34.1	14.4	17.9	5.2
19930, 19932	Subsoil	4.3	14.0	8.5	20.8	8.4	20.8	23.5

CONGAREE LOAM.

The surface soil of the Congaree loam is a brown, silty loam to a depth of 10 inches. A brown, heavy, fine, sandy loam of very limited extent occurs on a few of the low ridges and in places along the banks of the river. All of the type is a mellow and easily tilled soil. The subsoil to a depth of 36 inches and more is a brown, silty loam, being a little heavier and more compact than the surface soil. A few small mica scales are usually present in both soil and subsoil.

This soil type occurs only in the northern end of the county, following the Dan River. This strip of soil varies in width from one-fourth to one-half mile, and is well developed in the vicinity of Blanch. The Congaree loam occupies the flat bottom land along the Dan River, with a gradual slope to and with the course of the river. There are a few very gently rolling ridges, and also some few depressions and swales. The drainage is effected by open ditches, and most of it can be easily drained. It is subject to overflow, and occasionally the crops are badly damaged.

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The soil is of alluvial origin, being composed chiefly of silt, very fine sand, and clay, with a few small scales of mica. These materials have been washed from the hills and uplands and have been brought down by the Dan River and other streams and deposited during times of overflow.

This soil is especially suited to the production of corn, grasses, and oats. Corn yields from 20 to 40 bushels per acre under ordinary conditions, but as high as 60 bushels per acre have been made. Farms of this type, including some of the contiguous uplands, sell at about $10 an acre.

The following table gives the results of mechanical analyses of soil and subsoil of this type:

Mechanical analyses of Congaree loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19943	Soil	0.1	0.9	0.9	13.0	15.4	55.7	14.1
19944	Soil	.1	1.0	.8	8.4	19.9	52.2	17.7

MEADOW.

The areas of Meadow in Caswell County have no uniformity as to texture or depth. The soil varies from a loam to a sandy loam, and even a sand with considerable gravel. In a few places the soil is the same as the Congaree loam, but in most of the areas it is a variable sandy loam.

It occurs in narrow strips from a few yards to several hundred yards in width, following many of the streams. The largest and longest bodies of Meadow lie along Country Line, Hyco, Hogan, and Moon creeks, while small strips are found along some of their tributaries and other streams.

The Meadow comprises the low, wet land having an elevation of only a few feet above the normal water level of the streams. All of it is subject to frequent overflow, and part of it is wet during the entire year. A few spots, where the soil is similar to the Congaree loam, have been cleared and drained, and produce good yields of corn. A large part of the Meadow is covered with small bushes or forested. Some of it is used for pasture. By straightening the stream channels and cutting some ditches much of the soil could be brought under cultivation. Some areas would grow good crops of corn and grasses, and the remaining areas could be used advantageously as summer pastures for cattle.

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SUMMARY.

Caswell County lies in the northern part of North Carolina, bordering the Virginia State line. The county is nearly square in shape and contains about 400 square miles. The surface features are those of a high plateau which has been badly dissected by erosion, thus leaving level, rolling, and hilly surface conditions. Its general surface slope is to the north and the drainage is excellent. Many creeks flow through the county and empty into the Dan River on the north.

The county lies in the Piedmont section of the State, and its several soil types have been formed from the weathering of the underlying gneiss, schist, granite, diorite, and other rocks. Eight distinct types of soil have been mapped, including Meadow, and the area of each outlined on the soil map. The Cecil sandy loam is the most extensive type in the county. It is a gray or brown sandy loam underlain by red stiff clay. It is adapted to tobacco, corn, oats, wheat, cowpeas, clover, sweet potatoes, truck crops, and fruits.

The Cecil clay is a red or brown loam or clay underlain by stiff, red clay. It is well suited to wheat, oats, corn, clover, grasses, and cowpeas. It is a strong soil and is capable of high improvement.

The Durham coarse sandy loam is a light-gray, coarse, sandy loam underlain by a yellow friable clay. It is locally called "isinglass land." It is the best soil in the county for the production of bright tobacco, and is also well suited to potatoes and truck crops.

The Iredell sandy loam, which is often called "black-jack oak land," is a medium to fine sandy loam with a yellow to brown, waxy, impervious clay subsoil. Only the sandy ridges which are well drained are suited to tobacco. Oats, wheat, and grass give best returns on this land.

The Caswell sandy loam is a light-gray, sandy loam with a yellow clay or rotten rock subsoil. Some of it is suited to tobacco. Most of it should be seeded for pasturage, as the broken, rough, hilly areas do not permit of easy cultivation.

The Congaree loam occurs in a belt along the river. It is a brown silty loam, and is well adapted to corn and grass.

The small body of Herndon stony loam and the few strips of Meadow land are not used to any appreciable extent at present.

The main crop grown in the county is bright tobacco, more than 6,000,000 pounds being produced annually. The yield of the crop is from 500 to 1,200 pounds to the acre and it sells at from 6 to 40 cents per pound. The crop of next importance is corn, while considerable wheat and oats are also produced.

Land values are low, the same kind of land selling at much higher prices in other sections of the State. The growing of more grain and

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grasses and the raising of more stock would likely have a tendency to increase the selling price of much of the land. Some beautiful forests of hardwoods were observed, and from these could be manufactured valuable products at a profit.

Caswell County has a splendid climate. The rolling character of the land, the high elevation, the good drainage, and the excellent drinking water supplied from wells and springs make it a healthful section in which to live.

The main line of the Southern Railway crosses the northwest corner of the county, and the Norfolk and Danville, a branch of the same system, swings into the northeastern part. With railroad transportation through the interior of the county a more rapid development would take place. A large part of the population is at a noticeable disadvantage because of a lack of railroad facilities. A railroad through the central part would give strong encouragement to a more diversified agriculture, and would be a benefit alike to the towns and the country.

Yanceyville, the county seat, and Milton and Leasburg are the largest towns in the county. These places were manufacturing centers for tobacco and flourishing towns before the war.

Caswell County possesses an excellent and intelligent citizenship, its natural resources are great, its lands are cheap, and the large undeveloped areas invite settlers of the highest type.

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SOIL SURVEY OF GRADY COUNTY, GEORGIA.

By HUGH H. BENNETT and Party.

DESCRIPTION OF THE AREA.

Grady County, situated in southwest Georgia, on the Florida line, is bounded on the north by Mitchell County, on the east by Thomas County, on the west by Decatur County, and on the south by Gadsden and Leon counties, Florida. Cairo, the county seat, located near the center of the county, is in a direct line about 198 miles south of Atlanta, 200 miles southwest from Savannah, and 30 miles nearly north from Tallahassee, Fla. The area of the county is 294,080 acres or approximately 459 square miles. The base map is on the scale of 1 inch to the mile and shows the location of roads, towns, shoolhouses, churches, dwellings, railroads, streams, etc. It was made by the plane-table method of surveying, as the soil mapping progressed. The territory now included in the county was covered in an early survey by which it was divided into lots theoretically containing 250 acres each. In the present survey there was not sufficient time to resurvey these land-lot lines; in fact, this was considered unnecessary, as the location of the bodies of the various grades of soil, the primary object of the sur-

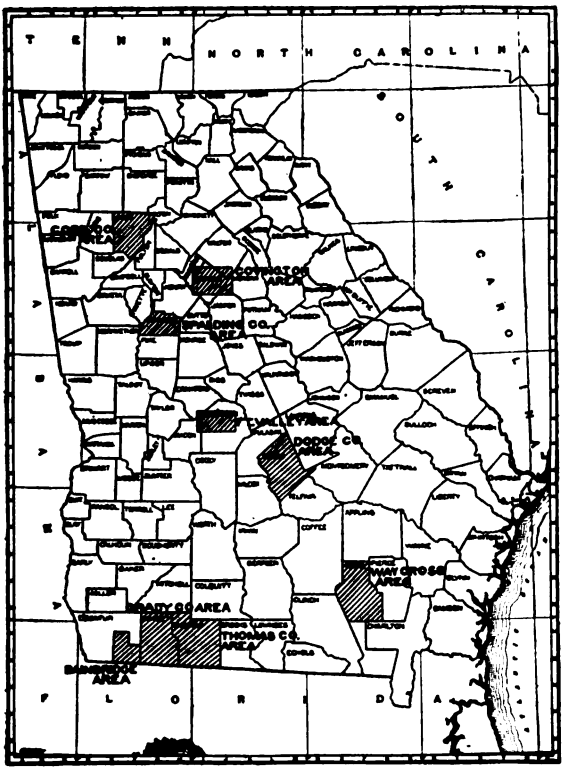

FIG. 8.—Sketch map showing location of the Grady County area, Georgia.

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vey, was satisfactorily accomplished with reference to other well-known and established points.

In its topographic aspect Grady County presents the appearance of a plain more or less interrupted by minor surface alterations due to erosion. The lay of the land would be described in a general way as flat or only gently undulating to gently rolling, varied here and there by minor ridges, hills, swales, and sink-hole depressions, and rather shallow, narrow stream valleys. There are few, if any, points in the county from which very extensive views of the surrounding country can be had. The altitude at Cairo is 235 feet and that at Meigs, just over the line from the northeastern corner of the county, is 341 feet. There are some conspicuously rolling sections, as in the neighborhood of the large streams, where erosion has been most active in dissecting the land surface. To the south of Cairo is found the most uneven country, and here the stream valleys are widest. The surface is sufficiently eroded, however, in places along Barnetts Big and Little Tired, and Turkey creeks, and the Ocklocknee River to give the land a fairly rolling topography.

The black-jack lands of the northern and northwestern parts of the county are often rather hilly, even at considerable distance from the larger drainage ways, but the hills are low and usually quite rounded. A peculiar topographic feature is presented in the low, flat, or "slough" lands of the northwestern part of the county, as is interestingly seen in the "Big Slough," a perfectly flat stretch of country having the appearance of a well-defined stream bottom without a stream, excepting the small branches entering from the adjacent higher country. All water entering this slough gradually disappears by sinking into the ground.

The many sink-hole openings into the underlying limestone give rise to some very interesting surface features. There is a beautiful water fall[a] at the Lime Sink just west of Spring Hill Church in Lime Sink district, where a perennial stream of considerable size flows over the brink of the sink hole in a fall of about 65 feet to disappear in the limestone cave below. The sudden entrance of the stream into this sink hole without any noticeable change in the surrounding topography affords a striking illustration of the peculiar surface configuration that may be encountered in a country underlain by limestone. In this sink there is exposed a good geological section, the upper portion of which consists mainly of a mottled sandy clay several feet thick representing the sedimentary material deposited over the limestone during the existence in this region of a prehistoric sea. Limestone, the color of which varies from light gray to greenish gray, underlies this soil layer to the bottom of the sink hole.

[a] McCallie refers to this as Forest Falls, Bul. 5, Geological Survey of Georgia, pp. 55–56.

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This rock contains numerous fossil shellfish and occasional bones of prehistoric animals. The depth of the depression is gradually diminishing because of the sand accumulation by deposition from overloaded drainage water, especially that from the nearby road. The vast quantities of soil material carried off underground through such erosional activity undoubtedly illustrates the process by which some of the low "slough lands" of this region have been formed. In Blowing Cave district there is an opening into an underground passageway known as the Blowing Cave on account of the peculiar alternate passing in and out of a current of air from the opening in the bottom of the shallow lime sink.

Other very interesting surface features due to the uneven dissolution of the basal limestone are seen at various points as at the water falls south of Blowing Cave, the deep conical depression known as Bay Sink, etc.

The larger streams all have unbroken stretches of flat bottom land ranging from narrow strips to the broad "river flats" of the Ocklocknee River. Low bluffs extend along the river here and there, but they quickly recede to give way to the flat bottom land again. These bottom lands are cut by streams, old stream channels, minor depressions, and hummocks. They are all subject to overflow. In places the outer margin of the bottom land is marked by a distinct bluff, above which stretches away a perfectly flat country, having somewhat the appearance of a second bottom, as illustrated in the flat lands between Pine Park and the river to the south. That they are not true second bottoms is shown by the fact that there are throughout the county similar broad, flat stretches in the interstream upland country having identically the same soil characteristics. Again, there may be a gradual ascent from the bottom land to the flat upland level, with nowhere any marked break in the surface configuration.

The small streams, in places mere wet weather drainage-ways, are fringed by strips of low, wet land supporting growths of magnolia, bay, black gum, sweet gum, and other water-loving trees and shrubs.

Although the turpentine and lumbering industries have exhausted the merchantable timber over large sections of the county, there are some extensive bodies of longleaf pine, interspersed here and there with slash pine, black pine, scrub oak, and dogwood. Small bodies of "hammock" land are found, which support a growth of hardwood, principally magnolia, beech, dogwood, white, red, post, water, live, and black-jack oaks, hickory, poplar, maple, bay, black gum, and sweet gum. True stream bottom land is timbered principally either with pine—longleaf and shortleaf—or with hardwood interspersed with pine, the latter mixed growth usually occupying the heavier bottom land. The shallow upland ponds and "sloughs"

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support thick growths of cypress, mayhaw, or black gum, and are called, according to the growth, "cypress," "mayhaw," and "black gum ponds" or "sloughs."

Grady County, laid off from Decatur and Thomas, was organized January 1, 1906. Settlement began in the present territory of the county in the early part of the nineteenth century, but advanced slowly until given an impetus by the opening of the Atlantic Coast Line Railroad. The settlers came largely from the older section of the State and from other Southern States. One section of the county is referred to as the "North Carolina Colony," for the reason that the inhabitants here immigrated largely from North Carolina.

The Atlantic Coast Line crosses the county about its center from east to west, affording quick transportation to a large part of the area. Public roads are very good, on which account distance to market becomes much less a burden to many outlying farms.

CLIMATE.

The climate of Grady County is quite similar to that of Thomas, and the following table, showing the mean monthly and annual temperature and precipitation, as recorded by the Weather Bureau station at Thomasville, may be taken to represent closely the conditions here:

Normal monthly, seasonal, and annual temperature and precipitation.

Month.	Temperature.			Precipitation.		
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year.	Total amount for the wettest year.
	°F.	°F.	°F.	In.	In.	In.
December	53	79	13	3.9	2.5	7.0
January	52	81	17	3.5	3.5	3.8
February	54	81	2	5.0	4.1	4.8
Winter	53			12.4	10.1	15.6
March	61	87	22	4.7	3.4	5.4
April	67	92	35	3.6	3.4	5.8
May	74	101	43	3.7	1.3	7.7
Spring	67			12.0	8.1	18.9
June	80	102	48	5.4	5.6	8.8
July	82	106	62	6.8	7.7	4.8
August	81	101	61	6.3	4.3	5.5
Summer	81			18.5	18.6	19.1
September	77	99	46	4.8	0.7	6.4
October	68	97	35	3.4	3.3	2.0
November	59	88	26	2.7	0.5	3.1
Fall	68			10.9	4.5	11.5
Year	67	106	2	53.8	41.3	65.1

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The winters are comparatively warm. Snow very rarely falls and a temperature lower than 30° F. seldom occurs, although during the period between November 20 and March 1 killing frosts and thin formations of ice are not uncommon. Flowers, such as violets, roses, and japonicas, are in bloom throughout nearly the entire winter and some vegetables can be grown the year around. A great number of early vegetables can be grown without much danger from frost after the middle of February, especially if cloth or some other material, as pine needles, is kept handy for covering the tender plants in threatening weather. Blackberries, dewberries, and cabbage seldom suffer from too much cold. Peaches and pears occasionally are damaged.

The long warm summers are moderated by breezes which make the nights in particular quite pleasant. June, July, and August, the hottest months, have a mean temperature of about 81° F. Temperatures of 100° F. are reached occasionally, and there may be even hotter days, but such weather is rather exceptional.

The rainfall is ordinarily sufficient for all crops, though corn, sugar cane, and watermelons sometimes suffer during dry spells in May, June, and July, especially on the light, sandy soils. Cotton is seldom damaged by drought, but it is injured at times by too much rain. With abnormal, heavy precipitation it is likely to go too much to stalk on the Norfolk sand and fine sand and on the deep phases of the Norfolk sandy loam and fine sandy loam. Tobacco also sometimes suffers considerably on the lighter types of soil from lack of moisture, on which account the production of the wrapper type should not be attempted on the Norfolk fine sand and sand without irrigation. Some tobacco growers are putting in irrigation systems for all their wrapper tobacco land under shade.

The shading of tobacco creates a more or less artificial climate, according to the completeness of the shading. Under cloth the atmosphere, owing to the high humidity and increased temperature, has a moist, tropical effect, favorable to a more rapid growth and earlier maturity of the plants, while the shade tends to increase the size of the leaves and to decrease their thickness. It is sometimes stated that the soil inside the cheese cloth tent dries out more rapidly than that outside, but experiments would indicate the contrary. Stewart says, "* * * the tent markedly affects the soil and atmospheric conditions. It affects the atmosphere by, first, slightly increasing the temperature; second, by increasing the relative humidity a great deal; and, third, by reducing the velocity of the wind. The last two of these reduce evaporation at the soil surface, which

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conserves the soil moisture and maintains the soil more nearly at the optimum water content."[a]

AGRICULTURE.

Cotton and corn have been the staple crops grown in the territory now included in Grady County practically from the beginning of agriculture. Potatoes, rice, oats, peas, and beans were grown quite generally in the early days for home use.

Live stock—principally cattle and hogs—had an important place in the early agriculture of this general region. Land, except cultivated fields which were fenced, was considered as open range, and the stock, kept in the woods the year around, naturally deteriorated. The wild cane which grew along the branches at first afforded green feed in the winter, but with constant grazing this soon disappeared, except on the larger plantations where much land was fenced. Some wild cane is yet to be seen on a few of these old plantations in the northern part of the county. Stock, cotton, and other surplus products of the farm were shipped to outside markets by the Flint River.

Hammock land was selected at first to the exclusion of the "piney-woods" soil, by reason of its greater productiveness, but in time it was learned that the latter would produce the same crops and make as good yields as old hammock land. As very little manure was used in the early days the impoverishment of land was met temporarily through the expedient of abandoning old land and taking up newly cleared ground, a practice that led to the gradual utilization of the longleaf pine lands to supplement the rather limited extent of hardwood land. The gravelly soils in the northern part of the county, which for a time were considered as undesirable for agricultural purposes, were found upon trial to be admirably suited to cotton. Thus every grade of soil in the county, with the exception of the poorly drained Portsmouth, the Grady loam, and bottom-land soils, which have never been used, has proved satisfactory in varying degrees for farming purposes. Those fields turned out on account of the lessened productivity either were brought again under cultivation after periods of "rest," or allowed to grow up to pine, which, where not too severely hindered by fire, quickly reforests the old fields.

Until about 1845 the farms were largely self-sustaining, though producing cotton as the main money crop. About this time there began a change. On the large plantations, where slave labor was employed exclusively, cotton was made almost the sole crop. This one-crop system proved unprofitable in many instances, particularly so as the lands became more and more run down, and finally a remedy was sought in the use first of Peruvian guano and then of commercial fertilizers. Here, as throughout the South generally, the use of chemical fertilizers has gradually increased since their introduction.

[a] Bul. 39, Bureau of Soils. Effects of Shading on Soil Conditions, p. 15.

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The production of rice, which for a long time was grown on many farms, has practically ceased. Notwithstanding long-staple cotton is grown on a considerable number of farms, it is not believed that its acreage is being extended. Within the last twenty-five years sugar cane for sirup has been grown in a quite profitable way and its production has been increasing gradually for a number of years. Watermelons have been an important crop for a considerable time.

Some time before 1860, "Florida tobacco," a distinct cigar-wrapper type, was grown on a small scale within the limits of Grady County. About fifteen years ago the production of the Cuban type of cigar-filler tobacco was taken up in the southwestern part of the county and a few years later the Sumatra cigar-wrapper type appeared and immediately proved a success. While some of the Cuban type is yet grown, the Sumatra leaf, almost since its introduction, has been the most important and profitable type. The tobacco industry, already well established in the Calvary section, appears to be spreading northward gradually. A number of farmers in the vicinity of Cairo, who grew their first crop in 1907, were not able to dispose of the product satisfactorily, partly for the reason that the financial depression of that year led buyers to curtail their purchases of leaf and partly because the crop grown in the sun on soils only moderately adapted to this type of tobacco was not altogether what the trade demanded. Finding themselves practically at the mercy of the buyers in the matter of disposing of their crop, some of the small producers did not put in a crop this season (1908), but most of the new growers who produced crops under shade and on the right soil were so well pleased with results that they planted again this year, some growers increasing their acreage considerably. Fields of shaded tobacco ranging in size from 5 to about 20 acres were grown near Cairo.

Most crops suited to the climate of this region can be grown successfully in Grady County. At present the important crops are cotton, corn, sugar cane for sirup, sweet potatoes, watermelons, peanuts, oats, velvet beans, and cowpeas. A great variety of vegetables and a number of fruits, particularly the pear, fig, grape, blackberry, and plum, find the soils highly adapted to their requirements.

Both the short and long staple (Sea Island) varieties of cotton are grown. That the long staple is produced on such a comparatively small scale is due rather to its longer growing period, the more intensive cultivation required, and the greater difficulty in the picking, rather than to poor yields. The long-staple cotton deteriorates quite rapidly unless new seed is secured now and then from the Sea Island regions, or great care is exercised in the selection of seed from the home-grown crop. In this connection Orton says:

Without seed selection Sea Island cotton can not be grown successfully for more than a few years in any latitude. The interior growers have always de-

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pended on the skillful seed selection of the Carolina planters and have continued to neglect the matter since this seed supply has been cut off by a growers' organization. No more improved seed can be had from the Sea Islands, and nothing is more certain than that the crop will continue to deteriorate rapidly until the interior growers begin work to improve it. They undoubtedly will rise to the occasion when they realize that their industry is at stake. They may be assured in advance that they will succeed to a degree limited only by the care and skill they expend.[a]

Cotton does best on the Tifton sandy loam, the "pimply," shallow areas of the Norfolk fine sandy loam and sandy loam, and on the Orangeburg fine sandy loam. On the deep sandy soils both the long and short staple varieties are inclined to go very much to weed in wet seasons. Although many farmers are careful in selecting their cotton fields, on the whole too little attention is given this matter, a result of which is that the crop is grown more or less on all the well-drained soils throughout the county. The best average yields of the long staple are made on the "pimply" lands, particularly the Tifton sandy loam.

Cotton is planted on ridges from 2½ to 3½ feet apart prepared by rebedding on the old middles or by bedding up land first plowed level. The latter plan is considered generally as the better, particularly where the breaking is done in the fall or early winter. With the exception of the sands and deep phases of the sandy and fine sandy loams, the land should be broken in the fall to a depth of from 5 to 8 inches, turning under all the vegetable matter left by preceding crops. The usual cultivation with sweeps and hoes ordinarily is as efficacious as could be desired.

Some damage is done to the crop on small areas by cotton wilt or black root. Such spots should be plowed deeply in the fall and cultivated to other crops than cotton for several years. An excellent rotation for areas thus affected is corn with velvet beans, oats, and sweet potatoes or peanuts. Cowpeas, except the variety called Iron, probably should not be used on these diseased areas.[b] Injury from this source seems to be most common on the clay or "gall" spots.

Cotton occasionally suffers from rust on the deep sandy soils, but by keeping these well supplied with organic matter, as can be done advantageously by introducing crops of velvet beans and cowpeas in rotation with corn and cotton, and by using barnyard or stable

[a] Farmers' Bulletin 302, U. S. Dept. of Agriculture.

[b] In the matter of crops grown in rotation with cotton on wilt-affected lands Orton (Farmers' Bulletin 302, p. 18) says: "On the other hand they are open to the serious objection that they (cowpeas) are very subject to root knot and greatly increase this disease. On land infected by cotton wilt or black root the loss is increased by the presence of root knot. Fortunately the Iron cowpea is immune to root knot and can be used with safety. In fields where it is certain there is no root knot any pea can be planted, but the trouble is that root knot frequently appears where its presence was not suspected."

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manure and fertilizers high in potash and phosphoric acid, the damage from rust can be reduced to a minimum.

Practically no attention is given the matter of seed selection further than occasionally to secure from other sections an improved variety of cotton, which when grown indiscriminately on all soils gives at best varying results. It has been shown that cotton bred on a stiff clay soil, as that found in the red lands of Piedmont, Ga., for instance, in all probability will not prove a success when grown on a decidedly different soil, such as a droughty sandy loam. Much improvement would result from persistent selection of seed grown at home from the most fruitful stalks not only of cotton, but also of corn, oats, and other crops.

Corn is planted both on beds and in the water furrow. In the latter case early cultivation usually is delayed for the reason that furrows can not be run close to the plants until they have attained a size sufficient to prevent their being covered up, as is quite liable to happen with the plants standing in a gutterlike furrow. Another objection to this method is that water sometimes stands around the young corn long enough to retard its growth materially. With the ridge system, where the bed is about 4 to 6 inches above the bottom of the intervening furrow, which in case of flat land is decidedly the better method, the cultivation is somewhat the same as for cotton, though not as intensive. A more nearly flat cultivation, as is approached in a degree where land is flat broken and the corn planted in the shallow "streaking off furrow," would probably give better results than the present ridge system. Planted either on the bed, in the water furrow, or "streaking off furrow" the corn is finally left at "laying by time" on tolerably high ridges.

Oats are grown by seeding broadcast on roughly prepared ground and in open furrows. Though the fall season is the best time to put in this crop, seeding is usually done in the spring, when the plants often are retarded by unfavorable moisture conditions in the soil, so that only moderate or poor average yields are made. When planted in furrows from about 15 to 24 inches apart, covered lightly and given shallow cultivation between the rows, it appears that the best average results are secured, especially on the lighter types of soil, such as the Norfolk sandy loam. The oat crop is either mowed or harvested with cradle or reaper. In either case it is used for hay on the farm. The cultivation of oats could be profitably extended as a winter cover crop and as a late winter and early spring grazing crop.

Oats do best on the Orangeburg fine sandy loam and shallow phases of the Norfolk sandy loam and fine sandy loam. Seeded on thoroughly prepared land—that is, land well harrowed and smoothed—the crop does especially well after velvet beans, particularly when

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moderately fertilized with barnyard manure and the usual cotton and corn fertilizers. The rust-proof varieties should be grown.

Velvet beans are grown like peanuts, on ridges between corn rows, in fields by themselves, or in the rows with corn. The best cultivation is about the same as that given corn. The vines make such a rank growth that it is often difficult to harvest the corn grown with them, and it is well-nigh impossible to harvest the vines themselves for hay; therefore they usually are utilized for pasturage. As a forage crop velvet beans rank high. A further argument in favor of a general extension of this crop is the fact that it not only replenishes any deficiency in organic matter, but also improves the structural conditions of soils by shading them. The crop does well on all the well-drained soils.

Cowpeas generally make a good vine growth on the Norfolk and Orangeburg soils, but occasionally they fail to fruit satisfactorily, particularly in wet seasons on the deep sandy soils. Planted in late June and early July better fruiting results as a usual thing. The Unknown, Iron, Whippoorwill, New Era, Black, and "Crowder" are varieties quite well suited to the area, the last four fruiting freely. Cowpea hay for marketing would prove a remunerative crop on a large number of farms. The crop affords also excellent forage for hogs and cattle, at the same time improving the soil immensely.

Cowpeas and velvet beans can be substituted for each other in several good rotations that should be more generally practiced. A good rotation is to follow velvet beans or cowpeas with corn, then with fall-sown oats; in the succeeding spring cowpeas or sweet potatoes should be grown, and the next year cotton. Such a scheme of course can be changed in detail to suit the conditions, the important point being to crop the land in such a way as to return sufficient organic matter to the soil to prevent its getting in that apparently lifeless condition favorable to excessive crusting and compacting. A crop of cowpeas plowed under in the half-matured stage is decidedly helpful to soils that have come into unfavorable structural conditions for want of proper rotation and fertilization. From 25 to 40 bushels of burned lime per acre applied to the surface, following the incorporation of green or partly green vegetation, as cowpeas, assists in a rapid conversion of such vegetable matter into humus.

The Orangeburg sandy loam and fine sandy loam and the shallow Norfolk soils in particular should be broken in the fall to a depth of from 6 to 10 inches, turning to the surface a thin layer of the heavy subsoil where possible. Instead of burning off the grass and the cotton and corn stalks, or any waste vegetation, in the effort to make cultivation easier, these should be plowed under in the fall or long enough prior to planting to permit decomposition of their organic material.

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Commercial fertilizers are used almost universally for cotton, corn, watermelons, sugar cane, and tobacco. Many different brands analyzing on the average 8–2–2[a] are used ordinarily in acreage applications of from 200 to 400 pounds for cotton and from 150 to 250 pounds for corn, indiscriminately on all soils. Green cotton seed is largely used as a fertilizer, it being the custom with many farmers to plow the seed under a short time before planting the crop, thus allowing a large proportion of the seed to come up. In the use of seed a better plan, according to a number of quite successful farmers, is either to kill them before planting or to turn them under when the ground is cold enough to kill them rather than to cause sprouting. It has been demonstrated that as a fertilizer for sugar cane cotton seen can not be used as profitably as the same value in cotton-seed meal.[b] The best practice unquestionably is to use the cotton-seed meal where distance to market does not make the exchange or sale of seed an economic disadvantage. An excellent fertilizer is made by composting cotton seed with barnyard and stable manure or these together with acid phosphate or kainit, or both. The home mixing of fertilizers is recommended in all cases and a number of farmers do this, using cotton-seed meal, kainit, and either acid phosphate or bone meal. It is an easy matter to mix these materials so as to bring the fertilizer up to any desired standard by knowing the percentage content of nitrogen, phosphoric acid, and potash of the various ingredients.[c]

Oats and peanuts are rarely fertilized, though both crops respond readily to the proper application of manures. From 200 to 250 pounds per acre of the ordinary cotton and corn fertilizers have been used with very good results for these crops. Commercial fertilizers when used on most of the well-drained soils of the county should be applied in conjunction with some form of organic matter so as to make their effects more lasting and beneficial.

The flat, shallow running sweeps and "scrapes" so largely used in the cultivation of crops are well suited to the soils of this region, in that they allow a portion of the disturbed soil to fall behind the plow so as to make a moisture-protecting surface mulch. In dry seasons the weeder is an effective implement to keep surface crusts and young grass destroyed, particularly in the cultivation of corn. It is best not to plow the flat, shallow surface soils when in a soggy condition, though very little trouble actually comes from plowing the soils of this region in general when too wet. Few cultivators and disk plows are in use, notwithstanding they could be used to advantage, especially in fields free of stumps. In the breaking of land the

[a] 8 per cent phosphoric acid, 2 per cent nitrogen, and 2 per cent potash.
[b] Bulletin No. 75, Bureau of Chemistry, U. S. Dept. of Agriculture, p. 23.
[c] Farmers' Bulletin 44.

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light "dixie" plow should be largely replaced by disk and large turning plows.

Beggarweed, crab-grass, Bermuda, crowfoot-grass, and sandspurs are valuable crops for hay and pasturage, but very little attention is given these, with the exception of crab-grass, which is cut to a considerable extent where left as a kind of second crop in watermelon fields. Bermuda does well on the well-drained soils and affords excellent summer grazing. Sorghum also succeeds admirably, affording good summer pasturage for all kinds of stock, especially hogs and sheep. This crop comes in very timely to supplement failing summer pastures. Winter vetch and rape could be grown to advantage as winter and spring forage crops.

There are few sections that so easily produce an abundance of forage crops. The opportunities for an extension of stock raising are most excellent. Green feed can be supplied readily the year around. Beginning with rye and oats in the spring and following with sorghum, cowpeas, Bermuda, velvet beans, peanuts, vetch, ruta-baga, rape, etc., hogs and cattle can have a succession of succulent green feed throughout the year. Fed regularly on such crops and finished on corn and potatoes, hogs can be grown for market profitably. It is estimated that in this improved way pork can be produced at a cost of from 2½ to 3 cents a pound.

Several systems of renting farming lands are in vogue. A number of landowners turn over to renters a certain area of cleared land, a "one-horse" or "two-horse" farm, including from about 35 to 40 acres to the horse, for a stipulated rental of lint cotton—usually one 500-pound bale for a "one-horse" tract. Such renters usually grow little else but cotton. Considerable land is tenanted on the "half-cropper" plan, that is, the tenant, for the use of land, tools, stock, stock feed, and for one-half the fertilizer bill, turns over to the landlord one-half of the staple crops produced. Probably 60 per cent of the farms are operated by the owners, who often have no other help than their immediate families. A large number of these owned farms could be classed as small farms, a fact which in no small degree accounts for the general prosperity obtaining among the farmers of Grady County. The renting of land, although often quite profitable in immediate returns, as a rule is not conducive to soil improvement. A large number of tenants are rather migratory in their inclinations, moving from one farm to another without expending any undue effort to accumulate property, in consequence of which they are never especially interested in building up the soils.

Labor has been scarce in some sections of the county for a number of years. The turpentine and lumbering interests draw considerable labor from the farm by paying higher wages than farm hands receive.

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It has long been so easy to make a comfortable living in Grady County that many farmers have not especially desired to exert themselves strenuously beyond this point. Notwithstanding this, diversification is gradually becoming more popular and farmers are getting more and more interested in matters outside their immediate neighborhoods and are studying the methods and results of farmers in other sections. They are thinking more about crop adaptations, the exact manurial requirements of their soils, and the best methods of handling them. The rural free delivery of mail and the introduction of tobacco have helped to inculcate a desire among farmers to know their agricultural relationship and the value of their products to other sections of the country. While there remains much to be done in the way of agricultural betterment, the soils are adapted to such a variety of crops that greater diversification and development must, in the natural course of events, come about. The county offers great inducements to the man of small means as well as to the capitalist desiring to invest in farm lands. The best grades of land can be bought at very low figures—in some sections at $10 to $15 an acre or even less, that is, for land not supporting valuable timber and turpentine forests. Of course there are sections, as for instance those in which the tobacco industry is highly developed, where land values are higher.

SPECIAL INDUSTRIES.

TRUCKING.

Although there is in Grady County a large extent of soil adapted to vegetables, the trucking industry, aside from watermelons, has not attained an important place in the agriculture of the county.

A large crop of watermelons is annually grown for shipment. The well-drained medium and deep phases of the Norfolk fine sandy loam and sandy loam and the Orangeburg fine sand and sandy loam are the best suited to the crop. The Tifton sandy loam and the "pimply" areas of the Norfolk soils, as well as the Orangeburg soils, produce an extra early melon. The Norfolk sand and fine sand, though used for this crop, are too droughty to give good average yields. With moderate fertilization the average yield is about one-half carload an acre.

The general method of preparing the land consists of flat breaking to a depth of 5 or 6 inches, checking off to bring the hills from 10 to 12 feet apart each way, and listing on the fertilizers applied either continuously in the drill or only in the hill. Fall breaking to a depth of about 8 inches, followed with a rebreaking in February, would seem to be advisable. The seed are planted about the first of March on ridges thrown up with two or more furrows, and weekly replanting follows to insure against damage from frost. Cultivation is done

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in one direction first with a "dixie" plow, which throws the dirt toward the vines until the entire middle is plowed out. Later cultivation is done with sweeps.

The best fertilizer is stable or barnyard manure or cotton seed-manure compost, used at the rate of from about 5 to 10 tons an acre, according to condition of the soil, in conjunction with 500 or 600 pounds of fertilizer analyzing about 10–3–4.

The Kolb Gem, Blue Gem, Triumph, and Rattlesnake melons are the best shippers. Other more delicate and better eating varieties, as the Thomas, Kleckley, Pierson, and Ice Cream, are grown for home use.

Watermelon wilt usually does such damage to succeeding crops that it is the practice not to use the same land again for melons until after a lapse of five to eight years. The vines and refuse fruit should be done away with as soon as possible in order to destroy material liable to cause a spreading of the disease to other fields.

Cantaloupes and cucumbers can be grown particularly well on the shallow and medium deep Norfolk soils. These crops offer inducements to the specialist.

There is a good opportunity to build up a profitable industry in the production of sweet potatoes for early shipment. A large crop of potatoes is grown for home use, but as yet almost no attention has been given this crop with the object of selling to outside markets. There is no reason why this general region should not make large shipments of early potatoes in competition with other sections less favored in point of earliness.

The medium and deep phases of the Norfolk sandy loam, fine sandy loam, and Tifton sandy loam are admirably suited to the crop. "Spanish yams," "parrot yams," "red yams," and a large list of other varieties are grown.

Planting should be done on ridges from 8 to 10 inches high, previously fertilized with a 8–2–10 fertilizer, mixed thoroughly with the soil at the rate of 500 to 1,000 pounds to the acre.

Potatoes do particularly well after grain and on new ground, for the reason that the incorporated vegetable matter gives the soil an open structure favorable to the development of good tubers. Strong stable manure used too liberally is apt to injure the crop, causing the potatoes to crack. From 100 to 200 bushels of Irish potatoes per acre can be grown on the Norfolk and Orangeburg soils having a depth of at least 10 inches of sandy loam overlying the sandy clay subsoil. Barnyard manure or cotton-seed meal used liberally in conjunction with 300 or 400 pounds to the acre of a phosphate-potash fertilizer analyzing about 8–6 or 8–8 can generally be counted on for good results. A light crop of rye turned under green a short time before planting the potatoes also is beneficial.

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Early cabbage does well on the medium and deep phases of the Norfolk fine sandy loam, with heavy applications of stable or barnyard manure in conjunction with 1,000 pounds of a 9–4–4 fertilizer to the acre. The growing of collards for the seed has proved quite profitable with a number of farmers. The seed is sold to commercial seedsmen.

Late sweet potatoes do well after collards. Tomatoes, turnips, radishes, lettuce, okra, English peas, and beans can all be grown very successfully on the Tifton sandy loam and Norfolk soils. Extra early crops can be secured from the "pimply" areas of the Orangeburg and Norfolk types.

All conditions except distance to market and special freight rates are favorable to the development of an important trucking industry. With a growth of the industry freight rates very likely would be adjusted to encourage this line of agriculture.

FRUITS AND NUTS.

LeConte, Kieffer, and Bartlett pears do well on all the well-drained soils, but the growing of pears has not become extensive because of the devastating effects of blight. Very good returns are had from the pears shipped, and there is a good opportunity for an extension of the industry along lines that would prove decidedly profitable to growers. Little or nothing is done now to control the ravages of pear blight, a disease which can be kept in check by pruning the affected branches and burning root and branch of the badly diseased trees. Of the varieties grown the Kieffer is the most resistant to blight.

Plums, blackberries, and dewberries do very well on all the soils, where drainage conditions are good. The fig finds the soil and climate preeminently suited to its requirements, and this fruit can be grown with but little attention. Strawberries do well on the heavier phases of the Norfolk and Orangeburg soils. The Scuppernong, Concord, and a number of other varieties of grapes well suited for wine and marketing can be grown successfully, particularly on the well-drained Norfolk soils, and on the Tifton sandy loam.

Pecans do exceptionally well, especially on the Norfolk fine sandy loam and upland hammock land. A good many trees are being set out in the vicinity of Cairo, and pecan nurseries are operated successfully near that place. A few peaches are grown for home use. Better results could be had with modern methods of culture.

SUGAR CANE.

Grady is the leading county in Georgia in the production of sugar cane strictly for sirup, Cairo with an annual shipment of 10,000 to 15,000 barrels (33 gallons each) being the most important shipping point for this commodity. The county embraces a large area of

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land highly adapted to this crop, and there are almost unlimited opportunities for further development of this already important and growing industry.

The medium deep phases (10 to 20 inches to subsoil) of the Norfolk fine sandy loam and sandy loam are the very best soils for the production of sugar-cane sirup of excellent quality. The deep sandy Norfolk and Orangeburg soils produce a very good grade of sirup, but require expensive applications of fertilizers, besides being rather too droughty for best results. The Tifton sandy loam, the shallow phases of the Norfolk fine sandy loam and sandy loam, and the Orangeburg sandy loam and fine sandy loam make heavy yields of sirup, but usually the quality does not equal that made on the other soils named.[a]

Sugar cane is planted on ridges from 3 to 5 feet apart and is cultivated much like corn, the important difference being that in the plowing less dirt is thrown around the cane stalks during the early stages of growth. Ordinarily all fertilizers used are applied at once in the drill. In planting, either the whole cane stalk or 18-inch sections are laid directly on the fertilizers or on the soil previously mixed with the fertilizer and then covered to a depth of 2 or 3 inches. Any surface crusting should be destroyed with a shallow running implement, so as to prevent retardation of the young sprouts and to permit the plants to enter upon their long growing season as early as possible. Cultivation, including hoeing and interrow tillage, is carried on longer than in the case of either corn or cotton. When a good growth has been made, which usually is about the middle of June, dirt should be thrown about the stalks with sweeps, so as to stop suckering or stooling. Following this, interridge cultivation is continued and the crop laid by about the middle of July with from 4 to 5 sweep furrows, which leaves the stalks upon a well-rounded high ridge. Cutting should begin as soon after frost as possible. Sirup making usually begins about the last of October and continues until after Christmas.

Sugar cane is one of the crops that is always fertilized. Barnyard manure, cotton-seed meal, various brands of commercial fertilizers, and home mixtures of phosphoric acid, kainit, and cotton-seed meal are used. About a ton of commercial fertilizer analyzing approxi-

[a] Wiley, speaking of the effect of soil and fertilizers on the chemical composition of sugar cane, says: The principal effect which a soil has upon the crop is shown in the quantity produced. It is well known, however, that the character of the soil also influences to greater or less extent the chemical composition of the crop. Crops which are grown on a very fertile soil are usually coarser in texture than those grown on one less fertile. If therefore we are seeking for a particular flavor, taste, or character of product it is to be remarked that the fertility of the soil has an influence of quite a marked character in many particulars. Bul. 75, Bu. of Chemistry, U. S. Dept. of Agr., p. 20.

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mately 8–2–2, in conjunction with from 25 to 50 bushels of cotton seed and about 5 tons of barnyard manure, is considered a good acreage application, though the average application is much less than this. The method of procedure in fertilizing is to vary the application with the soil texture—that is, the lighter the soil the heavier the application. Most farmers apply all fertilizing materials just before seeding. Some, however, apply all the cotton seed, barnyard refuse, and compost, together with one-half of the commercial fertilizer used, at the time of seeding, then the other half of the fertilizer about the first of June.

Experiments conducted on the Norfolk fine sandy loam indicate that for the medium phase of this type 1,200 pounds of a 10–3–5 fertilizer per acre before seeding, followed later with two applications of 100 pounds each of sodium nitrate alongside the plants at intervals of a week or two in June, is a very good plan of treatment. For best results with the deeper sandy soils the acreage application of the above fertilizer should be increased to from 1,500 to 2,000 pounds.[a]

Heavy applications of stable manure or well-rotted barnyard manure often give the sirup a dark color and an unpleasant taste. Sirup secured from rich "cowpen" land usually has an undesirable dark color and salty taste. However, either barnyard manure or compost when used in moderate quantities is very efficacious as a sugar-cane fertilizer. Cowpeas and velvet beans put the soil into good condition for a following crop of cane, and sweet potatoes also leave the soil in an especially good mechanical condition. It is generally considered that corn and watermelons do better after sugar cane than does cotton. A good part of the nitrogen needed should be supplied by growing the legumes.

The typical, medium deep, sugar-cane soils should be fall plowed to a depth of 7 to 9 inches. Stubble cane burned over in late winter or early spring, and "barred off" and disked, makes with the same cultivation and fertilization nearly as good yields as seeded cane. However, more attention is given the seeded crop; in fact, a second or rattoon crop is not always grown.

Seed cane is protected through winter by covering in windrows lightly with earth. The canes are often damaged by unfavorable weather conditions, and it would seem that some better method of saving them could be worked out. The stubbles ordinarily winter over in the rows without any protection further than an occasional

[a] It is fairly safe to conclude that there is little if any waste from an excessive application of potash and phosphate on plant canes, as the succeeding stubble crop will get the benefit; but an excessive application of ammonia will be lost, as it has practically all disappeared by the following year. (Bul. No. 93, Bureau of Chemistry, U. S. Dept. of Agriculture, p. 30.)

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light covering of earth and blades stripped from the last crop. The red cane, which does especially well, and other varieties are grown.

The yields of sirup run from 200 to about 600 gallons per acre, according to soil, cultivation, and fertilization. With fair treatment an average acreage yield of 400 gallons can be reasonably expected, provided the right soil is selected.

There are two evaporating establishments near Cairo which manufacture a large proportion of the sirup made in the immediate vicinity, but a good part of the product of the county is made in open kettles by the farmers. Occasionally the question of establishing a sugar factory is agitated, but such an enterprise probably would be inadvisable under present conditions, because it is not at all likely that enough cane would be grown within a reasonably limited area to supply a large sugar mill. A sugar factory recently established in Decatur County proved rather disappointing to the owners for this reason.

TOBACCO.

Grady County embraces a large area of the medium deep phase of the Norfolk fine sandy loam, the type of soil best suited to the production of Sumatra cigar-wrapper tobacco. There are other types, as the deep Norfolk fine sandy loam and the Norfolk fine sand, that produce a very fine grade of tobacco; but in seasons of drought the crop suffers to such an extent on these types that, without irrigation, tobacco growing is rather a hazardous industry. The Orangeburg fine sand, with a depth of about 24 inches to the heavy subsoil, makes a very fair leaf, especially where there is a light reddish tint to the sandy soil material below a depth of 16 or 18 inches. In the Amsterdam, Laingkat, and Attapulgus sections of Decatur County and in adjacent Florida territory some tobacco is grown on the Orangeburg fine sandy loam, but the product is inferior to that grown on the contiguous Norfolk fine sandy loam. It is claimed that the barn-cured leaf takes the color of the soil on which it is grown. At present the trade demands the light-colored wrapper produced on the Norfolk fine sandy loam having a depth of from 10 to 20 inches to the yellow fine sandy clay subsoil. The Cuban type of cigar-filler tobacco does best on the Orangeburg fine sandy loam, which is found in considerable areas in the southern part of the county.

The growing of Sumatra wrapper and Cuban filler tobacco began in the southwestern part of Grady County several years ago. The production of wrapper proved so profitable from the first that the industry has gradually spread and there is every reason to believe that there will be a considerable further extension. Several large fields of shaded tobacco were grown this year (1908) in the vicinity of Cairo. The producers of the best shade-grown leaf are getting remunerative prices, but a few who have not been careful in the

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selection of their soil, especially those growing crops in the open fields, have been somewhat discouraged in the disposition of their crops, this being particularly true of small growers in years of depressed market conditions. Farmers should not rush headlong into this highly specialized industry, but instead should first thoroughly acquaint themselves not only with the details of growing and curing the leaf, but also with the soils best adapted to the crop and with the market conditions affecting the disposition of the product.

The cost of shading an acre of tobacco with slats ranges from $200 to $250. The posts for carrying the slat supporters usually are set 12 by 20 feet apart and stand 9 feet clear. The intervals between the slats should be so arranged that from 40 to 60 per cent of the ground will be shaded, and in order to insure an even distribution of shade on the plants the slats should be laid north and south. In areas with a great depth of soil above the clay subsoil the leaf produced is lighter in texture than is the case on shallower soil, and therefore more sun is needed to give the leaf the desired "body" or texture—in other words, the depth of the surface soil should determine the width of space between slats. A substantially built shade should last for five years.

A barn 120 feet long, 40 feet wide, and 20 feet to the plates has a capacity of curing easily 5 acres of tobacco, and costs from $650 to $1,000. The barn should be located in the open, so as to insure good circulation of air.[a]

The seed should be sown from February 15 to March 15 on a moist sandy soil or in a "box bed" kept well watered and shaded with cloth. Tobacco land should be broken flat in the fall and to a depth of from 10 to 14 inches, using a subsoiler but avoiding the turning up of too much of the lower material. Twenty 2-horse loads of stable manure to the acre should be broadcasted about the 1st of March, and immediately plowed under to a depth of 6 inches. Follow this treatment with an acreage application of 400 pounds of slaked lime, which should be harrowed in thoroughly with a disk. About two weeks before transplanting, a mixture of 1 ton of cotton-seed meal, 400 pounds of steamed bonemeal, and 300 pounds of potassium carbonate or 400 pounds of potassium sulphate should be drilled in broadcast. Where this mixture is used in the drill it should be mixed thoroughly with the soil, which should be rebedded just prior to transplanting. Rows should be 4 feet apart and the plants from 10 to 14 inches apart in the row. The plants should always be watered when set out, as this causes the soil to settle nicely about the roots. In order to get a good stand and uniform growth the field should be gone over several times soon after transplanting for the purpose of setting new plants

[a] For description of tobacco barns see Rept. No. 62, U. S. Dept. of Agr., pp. 25-29.

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in the place of the unhealthy or dead ones. The best time for transplanting is from the 15th of April to the 20th of May, though good crops have been made when set late in June. The disadvantage of setting too early is that the cold soil causes a slow growth which tends to thicken the leaf, thus reducing the percentage of good wrappers, while on the other hand late setting tends to produce a leaf of undesirably light texture and affords the additional disadvantage of injury from the increased number of insects. In the preparation of land for a second year's crop of tobacco it has been found advisable to turn up the soil with a disk or turning plow at intervals of about two weeks during the winter—a process that puts the soil into an excellent, mellow condition.

About five or six days after setting the plants cultivation should begin. The first cultivation should be deep and close to the plants, using a scooter plow. Later plowing should be shallow near the plants and a little deeper toward the middle. Such cultivation should be done once a week or as often as is necessary to keep the soil well mulched, it being especially necessary to plow as soon as possible after rains in order to destroy any surface crust. It is the practice of some to plow the alternate middles of a field during the first part of the week, then the uncultivated middles in the latter part of the week. This has the advantage of avoiding disturbance of the entire root system at one time. Cultivation often continues until or even after pruning begins.

Bud worms and horn worms are destroyed by hand and by various mixtures of Paris green. Plants should be topped before blooming. Suckers appearing at the joint of leaf and stalk after topping should be removed, so as to direct the entire energy of the plant toward the development of the ripening leaves. On the strong Norfolk and Orangeburg fine sandy loams top suckers sometimes are allowed to bloom, so as to prevent too thick top-leaf development. The suckers are rarely harvested.

A good crop of Sumatra will run from 50 to 60 per cent wrappers, 22 leaves to the stalk being a good crop. The size and texture of the leaf varies with the soil, fertilization, and rate of growth. A slightly rounded leaf something like 18 inches in length makes a very desirable wrapper.

Priming usually begins about sixty days after transplanting. The leaves are picked from the bottom of the stalk as they ripen and carried immediately to the barn, where they are strung at the rate of 30 to 40 to a stick and hung to cure. The first 3 or 4 bottom leaves (having a length of at least 10 inches), which make "sand" wrappers and binders, should be picked a little green, otherwise they are inclined to cure with insufficient body. The middle leaves, which make light and medium wrappers, should be picked when the tips first show a change to light green or a mottled color. The top leaves

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are always heaviest and cure rather dark. The "tops" are used largely for binders.

In hanging in the barn the leaves should be distributed and spaced according to their texture, so that they will not cure too rapidly, in which event they are apt to have a poor color and an undesirable body. The light sand leaves, 40 to a stick, should be hung in the peak of the barn from 2 to 3 inches apart, where the humidity is sufficiently high to cause slow curing; the middles, 30 to 35 leaves to the stick, and tops, 30 to the stick, should be hung below the sand leaves and spaced 4 inches at the plate to about 7 inches at the bottom of the barn. Much care must be taken in the curing to prevent pole sweat, pole burn, and stem rot—the undesirable results of improper curing and unfavorable moisture conditions. With good, open weather the barn should be closed for three days after hanging or until the tips of the leaves begin to turn yellow, then windows should be opened during the day and closed at night, depending of course on the weather, to let in air enough to cause the leaves to dry out and yet retain pliability. In very warm weather the barn should be closed during the day and opened at night. In damp weather it is necessary to build small blazing fires here and there over the floor to drive out excessive moisture. When the color is set and the leaf in good case—that is, good pliable condition—which stage is reached with the drying out of the midrib, usually at the end of about three weeks, the tobacco is cured so far as the farmer is concerned, and is ready for further treatment—fermenting, aging, and assorting at the warehouse.

Sun-grown Sumatra is grown and handled about the same as the shade-grown. Its texture is always inferior to the shade-grown and the price received is much less.

It is believed that irrigation should be more generally practiced, especially in dry seasons when the growth is retarded, with the result that the quality is inferior and the yield less. Fields having a suitable surface could be irrigated by flooding the rows from pipes or troughs at a very moderate cost, especially where a good well or one of the many perennial streams is handy. The usual practice is to irrigate where cheese cloth is used. Very heavy yields can be secured and the effect of soil depth on the quality of the leaf can be materially lessened by creating the desired humidity in the air and by controlling soil moisture conditions.

Some tobacco growers buy cattle and feed them for the purpose of securing plenty of good manure. It is likely that a crop of winter vetch would improve tobacco land, especially where a light growth is turned under and followed with a surface application of 500 pounds of lime per acre. A heavy crop of green manure turned under might cause a too rank, heavy growth of leaf.

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The usual yields of shade-grown Sumatra without irrigation range from about 700 to 1,300 pounds per acre. Where the clay comes near the surface, especially in case of the Orangeburg fine sandy loam, heavier yields of an inferior product are secured.

The Cuban filler tobacco is grown very much the same as the Sumatra wrapper. A good fertilizer for the Cuban variety consists of a mixture of 1,200 pounds of cotton-seed meal and 300 pounds of sulphate of potash to the acre. This type of tobacco should be grown on the Orangeburg fine sandy loam and rotated so as to give an occasional green manuring crop. While very little Cuban is grown at present, there are good opportunities for an extension of the industry, inasmuch as the product is a very superior one.

SOILS.

The soils of Grady County are in the main identical with those of Thomas County. They are predominantly sandy, ranging from light sand to moderately heavy fine sandy loams. Over about 80 per cent of the county the grayish or pale-yellow sandy surface material, sometimes carrying iron concretions, grades into either a bright-yellow or a bright-red heavy sandy or fine sandy loam to clay loam at a depth anywhere from 5 inches to 3 or 5 feet—such material representing the various types of the Norfolk and Orangeburg soils. In small areas the sand or fine sand surface stratum persists to a depth of 10 or more feet. Ordinarily a compact sandy clay of variegated colors—pinkish-red, drab, and yellow mainly—is encountered at a depth of from 4 to 6 feet.

About 3 per cent of the county is occupied by dark-colored, poorly drained soils in which the surface material, high in organic matter, grades at a depth of from 10 or 15 inches to 3 or 4 feet into a compact, grayish-drab or mottled, saturated material. This character of material forms the Portsmouth soils.

There are but few clay exposures in the county, and these represent small areas from which the surface layer of sandy material has been removed by erosion, as is seen in the "gall spots" of slopes, where the surface flow-off has been most rapid. These heavy spots, as well as some small wet depressions and occasional hummocks of sand and gravelly areas, on account of their small extent and sometimes inaccessibility, had to be included with the more predominant types as nonconformities.

There is a marked absence of coarse sand and quartz gravel, the limit of coarseness in the original materials laid down as marine sediments being pretty closely represented by medium sand. The iron concretions, so abundant in the northern part of the county and found in small spots throughout the area, evidently have been formed in situ through processes of weathering since the recession of marine water. It is possible these pebbles are not true concretionary formations, as they show neither a concentric structure nor

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weak internal cementation, but they are usually rounded and always represent sandy or clayey material cemented solidly by iron oxides and hydrates, the result of precipitation of iron compounds from soil solution.

Differentiation of the sedimentary deposits by pre-emergence water action and by later post-emergence erosional processes due to surface unevenness largely accounts for the variety of soil types. The two main effects of erosion have been the removal of surface material bodily, thus bringing the heavy underlying material nearer the surface, and the washing out of fine material, leaving superficial sandy layers. While it is probable that the assorting action of water before the complete emergence of the country occasioned much differentiation in the component materials, translocation of the finer silt and clay particles by rain water since emergence has had considerable effect in the formation of the superficial sandy layers. That there were differences, however, in the depth of the sandy mantle at the time of emergence is evidenced by the occasional sandy ridges which could hardly represent other than original deep sand beds or beach lines.

Solution and chemical changes, particularly oxidation processes, have been active agencies of weathering, especially in relation to color changes and the formation of ferruginous pebbles. The better drained and aerated surface soils have tended to assume light colors, while the heavier subsoils through the oxidation of iron components have tended to assume red colors. The high oxidation of the iron compounds, as seen in the bright-red color of the Orangeburg subsoils, probably has resulted from the better drainage and aeration of the Orangeburg materials which, certainly in some places, accounts largely for the difference between this and the Norfolk series with its uniformly bright-yellow subsoils. There is very little difference in the soil components of these two series, both being similar texturally and made up of quartz sands, silt, and clay, with decidedly few complex mineral fragments. Both the Orangeburg and Norfolk series carry ferruginous pebbles similar in character of composition and mode of origin. Sometimes the Norfolk soils grade so imperceptibly from flat upland locations into the Orangeburg, occupying slopes with better drainage, that the line of separation is very indistinct—gradations that do not suggest marked differences either in the manner or time of deposition. However, the fact that the Orangeburg occupies extensive areas in the southern part of the county where comparatively little Norfolk is found, the converse being true in the northern part of the county, would indicate probable differences either in the time of deposition and emergence or in the manner of formation. The drainage of these Orangeburg soils in the southern part of the county is much more nearly perfect than that of the Norfolk soils to the northward. This is due to the greater surface unevenness and to the more mature drainage system in the former region.

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The Portsmouth soils owe their distinguishing characteristics mainly to poor drainage, which has favored the accumulation of organic matter and inhibited oxidation in the deeper soil and subsoil.

The subsoil of the Susquehanna fine sandy loam represents closely the character of the deep underlying materials of the area, but with this type there are in places indications of some slight influence from the underlying calcareous formation. It is probable that the material forming the soil belongs to a transition stage between the underlying Eocene and the later formations which give rise to the Orangeburg and Norfolk soils.

Meadow land in places represents more a soil condition, the result of poor drainage, than distinctive soil material. Usually the material is largely alluvial, lacking in textural uniformity, and is always soggy or poorly drained.

Swamp land simply represents intensely poor drainage conditions existing in alluvial soils of highly diverse character.

The Chastain fine sandy loam embraces the broad "river flats" and stream-bottom alluvium, having enough uniformity in composition to constitute a fairly well-defined soil type.

The Orangeburg soils according to geological classification belong to the Lafayette formation, while the Norfolk belong to the later Columbia formation. The former may have been exposed by a removal of the Columbia material, or they may represent earlier deposits not markedly altered since deposition.

There are in the county several small exposures of limestone, probably representing the Vicksburg-Jackson of the Eocene. A large part or all of the area is underlain by limestone which can be seen in several sink-hole exposures or openings into which streams sometimes enter. Portions of this limestone have been shown to contain phosphoric acid,[a] but no experiments have been made to determine whether such lime rock would be valuable as a fertilizer. The ordinary sink-hole depressions, as well as the more notable "lime sinks," like Lime Sink, Bay Sink, and Blowing Cave, are due to the unequal dissolution of the underlying limestone formation allowing the overlying materials to sink in. Some small areas of nearly white or greenish-yellow plastic clay exposures, as seen along stream slopes, apparently have been affected to a certain degree by the underlying calcareous material. Fuller's earth is found in a number of locations. In a few places in the northern and northwestern parts of the county where the limestone approaches closely to the surface small limy concretions or fragments of limestone are seen intermingled with the soil, but they are not in quantities sufficient to affect materially the character or crop value of the soil.

[a] Bul. 5. Geological Survey of Georgia.

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Drainage conditions, texture, and surface-soil depth are factors that strongly and directly influence soil productiveness. The organic matter practically controls structural conditions, directly affects the supply of moisture in the soil, and indirectly affects the productiveness to a great extent. Soils well supplied with organic matter are very much less inclined to bake or crust, are easier to cultivate, and are always more productive than the apparently lifeless, crusty, droughty lands deficient in organic matter.

According to relative percentage contents of gravel, of the medium, fine, and very fine grades of sand, of clay, and of silt, as determined by analysis, the soils have been classified into sands, fine sands, fine sandy loams, and sandy loams. These classes or types have been grouped into series having similarity in color, structure, topography, drainage conditions, etc. The Orangeburg series include the well-drained types having bright-red, friable subsoils; the Norfolk series, the gray or pale-yellow types, underlain by bright-yellow friable subsoils; the Portsmouth series, the black or dark-colored poorly drained types having drab and mottled subsoils; and the Susquehanna, though represented here by a single type, normally includes those soils characterized by mottled red and drab, plastic clay subsoils. The Chastain fine sandy loam, standing by itself as a local type, is probably found along many streams of southern Georgia.

The following classification shows the soils of the county grouped according to mode of origin and process of weathering:

Description.	Soil.
Gray soils with red subsoils derived from old sedimentary material (Lafayette), under best drainage conditions.	Orangeburg sandy loam. Orangeburg fine sandy loam. Orangeburg fine sand.
Gray soils with yellow subsoils derived from later sedimentary material (Columbia), under moderately good drainage conditions.	Norfolk sand. Norfolk fine sand. Norfolk fine sandy loam. Norfolk sandy loam. Tifton sandy loam.
Dark-colored soils with light-colored subsoils derived from Lafayette and Columbia material, under poor drainage or semiswampy conditions and intermittent wet and dry stages.	Portsmouth sandy loam. Portsmouth fine sandy loam. Portsmouth fine sand.
Grayish soils with mottled, plastic subsoils derived from the exposed formation underlying the later sedimentary material or representing the deeper substratum.	Susquehanna fine sandy loam.
Grayish-brown loam with heavy slightly mottled subsoil. Depression soil probably derived from sedimentary materials.	Grady loam.
Alluvium	Chastain fine sandy loam.
Unclassified alluvium and poorly drained upland depressions.	Meadow.
Unclassified alluvium very poorly drained	Swamp.

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The local names of soils have been brought out in their proper relationship to the several types under the type description. When soil boundaries have not been drawn absolutely accurate owing to the impracticability of perfect delineation, and when small inaccessible bodies of soil and areas too small to map on the scale used (1 inch to the mile) have been included with the predominant types, careful consideration of the type description will eliminate possibility of confusion on the part of one using the soil map. In some cases where small areas embraced wide diversity in soils it was necessary to map the predominating type or represent the average soil condition, relying upon the soil descriptions to bring out the detailed features.

The following table gives the names and areas of the several soil types shown on the accompanying map:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Norfolk fine sandy loam	123,392	41.9	Susquehanna fine sandy loam	4,096	1.4
Norfolk sandy loam	37,440	12.7	Portsmouth fine sand	4,032	1.4
Orangeburg fine sandy loam	32,256	11.0	Portsmouth fine sandy loam	2,624	.9
Meadow	31,360	10.7	Portsmouth sandy loam	1,088	.4
Norfolk fine sand	24,320	8.3	Orangeburg sandy loam	1,024	.3
Tifton sandy loam	9,088	3.1	Grady loam	896	.3
Chastain fine sandy loam	8,000	2.7			
Orangeburg fine sand	7,936	2.7	Total	294,080	.....
Norfolk sand	6,528	2.2			

TIFTON SANDY LOAM.

The Tifton sandy loam is a yellowish-brown to dark-gray heavy sandy loam, underlain at from 5 to 15 inches by yellow to bright yellow friable sandy clay. sometimes the soil, at a depth of about 28 inches, passes into a friable, compact yellow clay slightly mottled with reddish colors. A characteristic feature of the type is the presence of varying quantities, 10 to 40 per cent, of small, rounded iron pebbles disseminated through the soil mass. These pebbles are most abundant in the surface soil found on the flat or undulating areas in relatively high positions and on the knolls and crests of ridges. They gradually disappear with descent of slope, until the type passes into the Norfolk sandy loam or the Norfolk fine sandy loam on the lower slopes. The pebbles consist of ferruginous sandstone or claystone and apparently have been formed in the soil by the cementing of small quantities of sandy or clayey material by iron salts. The interior color of these pebbles is usually dark red and the structure quite firm, but occasionally in the lower subsoil a soft or rotten pebble will be found which has a yellow interior. The soft

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character and yellow color may be due to incomplete oxidation of the iron salts or to decomposition and hydration processes going on within the mass of pebbles. A reddish-hued yellow is sometimes seen in the subsoil of the better-drained areas.

Although the presence of large prominent grains of sand gives to the average of this type a rather coarse feel, there is present sufficient interstitial material to make the texture quite favorable to the maintenance of moisture. However, during protracted dry spells the soil unless properly handled is apt to get into a hardened condition which sometimes makes cultivation quite difficult. Plows are worn dull very rapidly in this soil.

The subsoil conserves moisture well and is near enough the surface to bring its store of moisture within easy reach of growing crops. As a rule crops do not suffer very greatly from drought, while on the other hand the very best crops of cotton made in the county, in wet years, come from this type and the "pimply" areas of other shallow surface soil types.

The Tifton sandy loam occupies nearly level and undulating upland, the gentle slopes along streams, the crests of ridges, and tops of low hills. The largest area lies to the southwest of Humphries School. Isolated areas are of frequent occurrence in the northern part of the county. The surface drainage is good everywhere, except, of course, in the unimportant swales and sink-hole depressions.

The Tifton sandy loam, locally called "hard, pimply land," is an excellent agricultural soil. Good average yields of cotton, corn, and sugar cane, the chief crops grown on the type, are made under the ordinary methods of culture. This is the best long-staple, or Sea Island, cotton soil in the area, though but little is grown on account of the long growing season and the greater care required in the production of this variety. Both long-staple and short-staple cotton give yields of from one-third to 1 bale per acre, according to fertilization and cultivation. Oats, corn, peanuts, cowpeas, velvet beans, sorghum, early Irish potatoes, onions, early melons, cucumbers, strawberries, and blackberries all do well on this land. The type is rather heavy and a little too compact in dry weather for the best results with sweet potatoes, though fair crops are made. This is a particularly fine early vegetable soil, but owing to the distance from railroads and markets little has been done along the line of trucking. Velvet beans and cowpeas improve wonderfully the structure and consequently the productiveness of the soil, and one or the other of these crops should be grown regularly in rotation with the staple crops. Crimson clover could be grown successfully for winter and early spring forage, as could also rye, vetch, turnips, and rape.

The ordinary grades of commercial fertilizers and cotton-seed meal are used extensively for cotton, corn, and sugar cane. A good

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rotation is corn with cowpeas or velvet beans the first year, sugar cane or oats the second year, and cotton the third year. Grown under this system and fertilized with from 400 to 500 pounds of a 10-2-5 fertilizer, cotton would average nearly a bale to the acre, while the yields of sugar cane, oats, and corn would run considerably above the present average. Very little nitrogen should be bought, as it can be secured readily by growing the legumes. Along with an increase in the production of forage crops more stock should be kept on nearly all the farms on this type. Barnyard manure is the most efficacious fertilizer on this soil for all crops except sugar cane and potatoes. Too heavy an application of barnyard or stable manure gives a dark color and poor flavor to sugar-cane sirup, and sometimes gives to sweet potatoes an inferior quality.

Cotton is generally planted on beds laid off closer together and is cultivated shallower than on the less gravelly soils. Fall plowing would be very beneficial, as would also an occasional incorporation of a half-matured crop of cowpeas.

The following table gives the results of mechanical analyses of fine-earth samples of soil and subsoil of this type:

Mechanical analyses of Tifton sandy loam.

No.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18862	Soil	2.3	11.8	9.3	43.5	12.6	11.1	9.3
18863	Subsoil	1.3	9.2	6.8	32.1	13.9	8.3	28.3

NORFOLK SAND.

The Norfolk sand is a gray sand usually slightly darkened in the surface 6 inches with organic matter. Below 6 inches, the color is a yellowish gray to pale yellow. Generally coarser grains are found in the lower portion, although there may be present more fine material here than in the overlying soil. The grains are angular, but not especially sharp. There are several small areas of a lighter colored coarse phase carrying a small percentage of rounded quartz gravel. This phase, commonly styled "white sand," is very incoherent and has in its present condition but little value as an agricultural soil.

The component materials of the Norfolk sand consist almost entirely of quartz grains, there being little evidence of other minerals. The silt and clay, though in very small amounts, help to bind together the coarser grains so as to make this a fairly compact, rather than a loose and open, incoherent soil. However, if cultivated without fre-

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quent replenishment of the organic matter, which is exhausted rapidly in cropping, it becomes a loose, droughty, and unproductive soil.

The type is found mainly in the northern and northwestern parts of the county. The largest body is the one which extends from the Mitchell County line along the Big Slough and the Decatur County line southward for a distance of 5 or 6 miles. The topography of this main body, although largely undulating, is varied by the occurrence of many slight depressions and sink holes. The timber growth is longleaf pine, interspersed with a scrubby growth of black-jack and other species of oak. There is a sparser growth of wire grass than on the heavier Norfolk soils. The deep substratum of this large area frequently is a very stiff, compact, mottled pinkish-red, yellow, and drab sandy clay. Several other widely separated areas of considerable size are found occupying stream slopes in the northern part of the county.

The Norfolk sand is a well-drained, somewhat droughty, and only moderately productive soil. Very little of it is under cultivation. Owing to its thorough aeration and drainage, it is a warm soil and well suited to certain kinds of vegetables. With heavy applications of barnyard manure or compost, in conjunction with liberal quantities of commercial fertilizer, good crops of early English peas, radishes, beans, cantaloupes, cucumbers, sweet and Irish potatoes, strawberries, and watermelons can be grown. For the reason that cultivation causes rapid depletion of the organic matter, a contingency that materially affects the productiveness of the soil, all crops should be grown in rotation with cowpeas or velvet beans. One or the other of these legumes should be turned under in the half-matured stage once in every two or three years. In this way the supply of humus may be readily maintained.

An excellent quality of sugar-cane sirup can be made, but the yields are so light without very heavy applications of fertilizer that very little of the soil is used for this purpose. Cotton, corn, and oats make only very moderate yields, and the soil should not be used for these crops where the heavier types are available.

Cotton is subject to rust on the Norfolk sand, and for that reason requires a fertilizer high in potash. Too heavy applications of barnyard manure or commercial fertilizer will cause cotton to "fire" or burn. A fertilizer analyzing approximately 10–2–8, used at the rate of about 300 or 400 pounds an acre, in conjunction with barnyard or stable manure, compost, or with some green crop turned under, will produce from one-fourth to one-half bale or more of cotton per acre in favorable seasons. It can be readily seen that such yields do not make cotton a very profitable crop. It has been the experience of some successful farmers that phosphoric acid and potash fertilizer in the percentage ratio of about 2 to 1, used at the rate

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of 800 to 1,500 pounds to the acre, is a very satisfactory application for sweet potatoes, melons, and vegetables. From 500 to 1,000 pounds of cotton-seed meal in conjunction with a phosphate-potash mixture would be a good application for Irish potatoes. With judicious management from 80 to 175 bushels of sweet potatoes and from 60 to 150 bushels of early Irish potatoes can be secured.

Fall plowing is not important except to turn under green vegetation. Frequent surface cultivation is necessary to conserve moisture.

The following table gives the results of mechanical analyses of the samples of soil and subsoil of the Norfolk sand:

Mechanical analyses of Norfolk sand.

No.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18851	Soil	4.0	23.1	14.8	35.2	11.6	7.9	4.0
18852	Subsoil	3.2	28.4	12.3	36.4	13.3	7.2	4.2

NORFOLK SANDY LOAM.

The Norfolk sandy loam occurs in two phases differing essentially in the depth to the subsoil. The shallow phase is a medium sandy loam underlain at about 10 to 15 inches by a mealy, friable, bright-yellow sandy clay. The surface few inches of the soil is usually gray or dark gray, while that below is pale yellow in color.

The soil of the deep phase consists of a gray to dark-gray, rather open, light sandy loam, overlying a pale-yellow material of the same texture. The subsoil of this phase is a light-yellow mealy sandy clay. Ordinarily the soil of both phases grades into the subsoil through a thin stratum of heavy sandy loam. There is always considerable fine material in the soil of the Norfolk sandy loam, although the larger medium grains often stand out so prominently that they give the soil a deceptive coarse feel. The interstitial fine material makes the soil in this area rather more loamy than is typical of the Norfolk sandy loam in other regions. On account of this fine material, the soil, especially the shallow phase, is inclined to run together during heavy rains and to harden at the surface under the heat of the sun. Sometimes a thin crust is thus formed which should be broken up as soon as practicable after the rains have ceased in order to restore the soil to a tilth favorable to the conservation of soil moisture. Vegetable matter when decomposed and thoroughly incorporated with the soil effectively counteracts this tendency to crust.

In local areas small iron pebbles occur in considerable quantities over the surface, throughout the soil mass, and in irregular layers anywhere in the soil profile. Where these pebbles occur in the sur-

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face soil the land is locally styled "pimply soil." Such gravelly land generally produces better than the average of the type. In some places in the northwestern part of the county, especially where black-jack oak is of common growth, the deep subsoil is quite stiff and plastic, this being particularly true where resistant fragments of rock, derived from outcrops of the underlying limestone formation, are found scattered over the surface. This stiffness in the deep subsoil disappears as the more dominant piney-woods phase is approached.

The Norfolk sandy loam is restricted largely to the northern half of the county. The surface varies from flat to hilly, the hills being low and generally rounded. The deep phase is most commonly found on slopes where accumulations of material washed from above has increased soil depth. The large area northwest of Whigham is almost flat. The shallow phase of the type is quite diverse in its topographic features, the more rolling areas being found in the black-jack hammock lands in the northwestern part of the county.

The timber growth mainly consists of longleaf pine, though in some locations there is considerable black-jack oak. Wire grass is found everywhere in the longleaf pine woods. Natural drainage is very good. The soil conserves moisture surprisingly well, and most of the crops grown rarely suffer from drought where frequent shallow cultivation is given. Corn, however, is inclined to suffer in dry seasons, especially where the organic matter has been depleted. In general the crop value of the Norfolk sandy loam depends upon the depth of the surface soil and the organic matter content. The type as a whole is a fair cotton soil, but the better yields are secured from the shallow phase, especially the "pimply" areas. The effect of manure is always more lasting where the soil depth is shallowest.

The Norfolk sandy loam is well suited to corn, sweet potatoes, Irish potatoes, sugar cane, sorghum, forage crops, watermelons, cantaloupes, beans, and tomatoes. The soil depth should be at least 10 inches for best results with potatoes, corn, sugar cane, and wrapper tobacco. The principal crops are cotton, corn, sugar cane, oats, peanuts, sweet potatoes, and watermelons. The yields per acre range from one-third to three-fourths bale of cotton, 10 to 20 bushels of corn, 300 to 450 gallons of sirup, 100 to 300 bushels of sweet potatoes, and from 15 to 25 bushels of oats. These yields do not represent the maximum capacity of the soil, but rather what may be expected under the prevailing methods of soil management. Heavier yields, especially of cotton, sugar cane, and oats, can be secured easily from the shallow and "pimply" areas with proper management. Long-staple cotton succeeds very well on the gravelly and shallow surface soil areas. Some good crops of sun-grown wrapper tobacco have been secured where the soil texture runs somewhat finer than the average of the type. As a

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general thing this soil is too open for best results with wrapper tobacco, but pretty fair crops could be grown where the soil has a depth of from 10 to about 15 inches over the heavy subsoil and is not of a distinctly coarse, incoherent character. This latter phase would be too droughty for good results without irrigation. Peanuts do well everywhere on this soil. Strawberries, English peas, and pears could be grown more extensively for market, as they do remarkably well.

The soil is susceptible of rapid improvement by growing cowpeas and velvet beans. A crop of cowpeas turned under occasionally very much improves the structural conditions of the soil. Commercial fertilizers of the ordinary grades are used generally at the rate of from 350 to 400 pounds for cotton, 150 to 250 pounds for corn, 300 to 600 pounds for watermelons, and from 500 to 1,600 pounds for sugar cane. Oats and peanuts are very seldom fertilized, although they would be benefited by the same applications used for cotton and corn. According to the experience of the most successful farmers, a fertilizer analyzing 10–2–3 for the shallow phase and about 10–3–5 for the deep phase is the most efficacious commercial mixture that can be used for corn, oats, and cotton. Where the organic matter content of the soil is low, chemical fertilizers should be used always in conjunction with such organic manures as compost, barnyard or stable manure, or a crop of half-matured vegetable matter, preferably cowpeas. Sweet potatoes do not need so much organic manure, but moderate applications of rather coarse barnyard refuse in conjunction with 500 to 1,000 pounds to the acre of something like a 8–2–10 fertilizer give excellent results. Nitrogen should be largely supplied by growing the legumes. Fall plowing to a depth of 9 to 10 inches should be practiced generally on the shallow phase and also on the deep phase, where there is a growth of vegetation that could be converted into humus.

The following table gives the average results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Norfolk sandy loam.

No.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18573, 18866	Soil	2.1	15.1	13.3	38.5	15.3	9.1	6.5
18574, 18867	Subsoil	1.2	10.0	8.6	33.6	11.3	8.7	26.5

NORFOLK FINE SAND.

The Norfolk fine sand is a rather loose, gray to dark-gray fine sand, underlain at from 6 to 15 inches by a light-gray to pale-yellow, incoherent, velvety fine sand. Considerable areas of this type are found adjoining the stream bottoms either as sloping or as comparatively

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flat land ranging from a few feet to 30 or more feet above the level of the bottom. This phase usually supports a growth of longleaf pine interspersed with a scattering growth of scrub oak. A few isolated scrub-oak areas occur in the uplands as slight ridges and knolls. This phase is considered a droughty soil and but little is under cultivation.

Another phase found along stream slopes and as isolated upland areas supports a growth of magnolia, beech, dogwood, several varieties of oak, black and longleaf pine, and other hardwood timber, and is called "sandy hammock land." The soil here is more loamy owing to the accumulation of leaf mold, and when cleared produces good crops of corn, cotton, sugar cane, and peanuts for several years, or until the store of organic matter has become exhausted. After the depletion of organic matter, heavy applications of fertilizers, or manure, are required for good results, just as with the scrub-oak phase.

The soil mapped as Gadsden sand in the survey of the Bainbridge area, a portion of which has been revised in the survey of Grady County, has been included with the Norfolk fine sand for the reason that from further study it seems to represent in the main the hammock phase of this type.

The Norfolk fine sand, particularly the fresh hammock phase, would produce good light wrapper tobacco with irrigation especially under cheese-cloth shade. From 10 to 20 bushels of corn, 600 to 900 pounds of wrapper tobacco, 250 to 400 gallons of excellent light-colored sugar-cane sirup, and from one-third to one-half bale of cotton per acre can be secured under good management.

Only moderate yields, however, of corn, cotton, and sugar-cane sirup are secured under the ordinary methods of management. The soil is adapted to about the same crops as the Norfolk sand, though considered a little more productive than that type. Cowpeas and velvet beans should be grown frequently in rotation with other crops in order to maintain in the soil a good supply of organic matter.

The Norfolk fine sand is really a special-purpose soil, being well adapted to vegetables, such as Irish potatoes, sweet potatoes, watermelons, cantaloupes, radishes, lettuce, and English peas. For these crops heavy applications of fertilizers are always required. Irish potatoes and sweet potatoes, particularly, could be grown for early market. Sugar cane, watermelons, and tobacco (without irrigation) suffer so much from scarcity of moisture in dry seasons, while on the other hand cotton makes such a heavy growth of weed in rainy seasons, that, as a rule, these crops can not be profitably grown either on the incoherent scrub-oak phase or the "run-down" hammock phase without too expensive an outlay for fertilizers. Cowpeas also are apt to produce mainly a vine growth in wet years.

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The occasional plowing under of green vegetation like cowpeas is very beneficial for all crops, in fact profitable utilization can not be made of the soil except by keeping it well supplied with organic matter—either barnyard or stable manure or other vegetable matter. Commercial fertilizers always are more lasting and beneficial when used in conjunction with some form of organic matter.

The following table gives the results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Norfolk fine sand.

No.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18854	Soil	1.4	13.4	8.0	47.0	16.3	9.9	4.1
18855	Subsoil	1.6	12.4	8.7	48.7	18.4	7.1	3.1

NORFOLK FINE SANDY LOAM.

The Norfolk fine sandy loam is one of the most important agricultural soils in the county or in this general region. It is so variable in the depth to its clay subsoil, and these variations affect its agricultural value so materially, that the type was separated into three phases and these outlined on the map. Broadly speaking, the type is a gray to dark-gray fine sandy loam, underlain somewhere between 5 and 36 inches by a friable yellow sandy clay. Frequently small iron sandstone pebbles in varying quantities may occur scattered over the surface, disseminated throughout the soil mass, or principally in a section of the soil profile. Such areas where the pebbles are abundant in the surface soil are called "pimply land," and the soil is considered stronger than where the pebbles are lacking. Very little of this "pimply land" is found south of the Atlantic Coast Line Railroad. The deep substratum as exposed in road cuts and streams is generally a compact fine sandy clay mottled pinkish-red, yellow, and drab.

The timber growth consists mainly of longleaf pine. "Slash" pine is found occasionally in the poorer drained situations, as is also magnolia, dogwood, and hickory. A hardwood growth is often encountered on slopes and here and there, in comparatively small areas, in the uplands. Such hardwood timbered land is called "hammock land" and is always considered exceptionally good soil. As a rule the hammock land seems slightly more loamy and mellow, and the content of organic matter is a little higher and apparently in a better condition than in case of the "piney woods" land. After two or three years' cultivation without supplying organic matter the soil of the "hammock" areas assumes the same characteristics as the

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piney woods land. There usually is a good growth of wire grass over the pine-timbered land. Gallberry bushes grow scatteringly in the damp places.

Shallow phase.—The shallow phase of the Norfolk fine sandy loam is a light to moderately heavy fine sandy loam, underlain at a depth of 10 inches or less by a yellow heavy fine sandy loam which quickly passes into a bright-yellow fine sandy clay. The color of the soil, usually a dark gray or brownish gray in the surface 4 or 5 inches, changes to a pale yellow below. Where the land has been under cultivation for several years without restoring organic matter, the color is distinctly a lighter gray than in the timbered land. Again, where plowing is done deep enough to turn up the subsoil, the color of the soil is thus artificially changed to pale yellow. The subsoil is generally quite friable when moderately dry, but in wet weather it sometimes becomes noticeably plastic and soggy. There are small eroded areas on some of the slopes where the clay subsoil has been exposed. Pebbly areas of this phase are referred to as "hard pimply land."

This grade of soil is found in small flat and undulating areas here and there over the county. Only a small area was mapped, but there are other bodies which, owing to their small size, were included with the medium phase. The soil is inclined to become waterlogged in protracted spells of wet weather and to harden in dry weather. Where the surface is flat, ditching would improve these conditions. Shallow cultivation as soon as possible after soaking rains is necessary to destroy any surface crust.

This is a very good soil for long-staple and short-staple cotton, oats, peanuts, and forage crops. Corn, watermelons, sweet potatoes, cantaloupes, and tobacco do better on the deeper phases. Heavy yields of sirup are secured, but the quality is inferior to that produced on deeper soils. Medium late crops of tomatoes, Irish potatoes, beans, and peas could be grown successfully. By plowing deep so as to turn up a portion of the subsoil, and by seeding in the fall, oats would do well, especially after a leguminous crop.

Commercial fertilizers when used should be applied in conjunction with organic manures, lot manures, the stubble refuse of cowpeas and velvet beans, or even with cowpeas turned under when partly matured.

Medium phase.—The medium deep Norfolk fine sandy loam consists of a light to medium heavy gray to dark-gray fine sandy loam, underlain, at from 10 to 20 inches (averaging about 15 inches), by a yellow heavy fine sandy loam which quickly passes into a bright-yellow friable fine sandy clay. The surface few inches of the soil is always darker colored than the portion below. The color in cultivated fields is lighter than that under timber, particularly under hardwood, while the color in poorly drained situations is sometimes almost black.

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This phase carries less silt and clay than the shallow phase, yet there is present enough fine material to cause surface crusting with sunshiny weather following rains. In the well-drained situations the subsoil possesses a mealy structure very favorable to conservation of moisture in the condition most readily available to crops in time of dry weather. On the poorly drained areas and on the lower slopes of streams, where sometimes the color is reddish yellow, the subsoil not infrequently is slightly plastic. Under such a condition the type is less productive. In the northern and northwestern parts of the county there is a "black-jack hammock" phase which is quite rolling to slightly hilly. In this section the subsoil is often quite stiff and heavy, especially in proximity to the Susquehanna fine sandy loam areas. The soil here, too, seems to be lighter colored and lower in organic matter than under the average conditions.

The medium deep Norfolk fine sandy loam is also found in the low, flat, poorly-drained slough land situated in the northern part of the county. The greater part of this phase, however, occupies flat, undulating, and gently rolling country. The natural drainage is excellent, and but little erosion has taken place.

Cultivation is possible under a fairly wide range of moisture conditions, but the soil should not be disturbed while wet or miry. Tendency to crust and harden varies with the content and condition of the organic matter. There is no need of the soil getting into unfavorable structural conditions when it is so easy to grow crops like cowpeas and velvet beans which add humus and open up the soil and subsoil to the beneficial action of the air. Such crops are beneficial whether cut, grazed (in good weather), or plowed under. A half matured crop of cowpeas should be turned under occasionally. These crops should be grown regularly in rotation with cotton, corn, oats, and other staples.

The medium deep phase of the Norfolk fine sandy loam, as a whole, is the best soil in the county. It is well suited to a wide range of crops and is the most certain to produce good average yields. All the crops grown in the county do at least fairly well on this grade of soil. The average yields per acre are about one-third bale of cotton, 8 to 25 bushels of corn, 200 to 450 gallons of sirup, 15 to 20 bushels of oats, and 100 to 200 bushels of sweet potatoes. These yields could be increased largely by fall plowing, by growing more leguminous crops, and by using commercial fertilizers in conjunction with some form of vegetable manure; as compost, barnyard refuse, or green manure. The pebbly areas are best for both long-staple and short-staple cotton, early melons, and Irish potatoes. It is as well suited to corn as any other soil in the county, the best yields being made where the soil portion is deepest.

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This is the best wrapper-tobacco soil in the county, being identical with that on which the best grades of wrapper tobacco are grown in Florida and in Decatur County, Ga. It is capable of producing from 1,000 to 1,300 pounds or more of shade grown, and from 500 to 1,000 pounds of sun-grown wrapper tobacco to the acre. The hammock land, when first cleared, is an especially good wrapper-tobacco soil. This is also the best sugar-cane soil, producing 600 gallons of sirup per acre, with proper fertilization. Early sweet potatoes and early cabbage could be profitably grown for market. Peanuts, cantaloupes, cucumbers, sorghum, and small berries do well. Pecans find this soil as it occurs in the gently rolling to undulating areas admirably suited to their requirements.

Ordinarily, applications of from 500 to 1,500 pounds of commercial fertilizer are used for sugar cane, 500 pounds for watermelons, 150 to 250 pounds for corn, and from 200 to 500 pounds for cotton. The experience of successful farmers on this soil would indicate that the best fertilizer for cotton and corn should analyze 10 per cent phosphoric acid, 2 per cent nitrogen, and 5 per cent potash. Sweet potatoes, especially the Spanish or Parrot yam varieties, fertilized with about 1,000 pounds of something like an 8–2–10 mixture should yield about 400 bushels per acre. Excellent crops of crab grass are made after watermelons without seeding. Tobacco culture on this soil was discussed under the heading "Special Industries."

There is a large area of the medium deep Norfolk fine sandy loam in the county.

Deep phase.—The deep phase of the Norfolk fine sandy loam is very similar in color and texture to the medium phase and differs from it essentially in its greater depth to the subsoil clay. The soil carries a little less silt and clay, and on that account is generally less compact and less inclined to crust than the two shallower phases. Typically developed, this phase is a gray to dark-gray loamy fine sand to light, fine sandy loam, underlain at from 20 to 30 inches (averaging about 24 inches, by a yellow, heavy fine sandy loam which quickly passes into a bright-yellow clay loam or fine sandy clay. The organic matter is more rapidly exhausted under cultivation than with the shallower phases.

This phase of soil is found throughout the area, occupying nearly every variety of topography peculiar to the county, but more generally occurs along slopes and on indistinct ridges. The medium-deep phase of the Norfolk fine sandy loam frequently grades so imperceptibly into this deep phase with descent of slope that it is difficult in places to establish the boundary between them.

The natural drainage of the deep phase is good in the main, but some of that found in the low, flat situations so common in the north-

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western part of the county is poorly drained, soggy, and rather unproductive under present conditions. These flat areas, however, could be ditched and made desirable agricultural lands. The higher lying cultivated areas in which the organic matter has been allowed to run so low that the soil has a lifeless appearance are apt to be droughty. The tendency for crops to suffer on such areas in dry weather can be largely overcome by turning under occasionally crops of cowpeas and by sowing cowpeas and velvet beans in regular rotation with other crops.

This soil is especially adapted to watermelons, sugar cane, sweet and Irish potatoes, and corn. Cotton is inclined to run to weed in wet seasons. Cowpeas frequently fail to produce seed in wet seasons. The yield of sugar-cane sirup is lower than on the heavier phases, even with the same amount of fertilizer, but the sirup is light colored and of superior quality. From 1,500 to 2,000 pounds of fertilizer can be profitably used in growing sugar cane, the yields varying with such applications from 300 to 450 gallons per acre. There is not a better watermelon soil in South Georgia, provided from 400 to 800 pounds of a good grade fertilizer are used. The best grade seems to be one analyzing something like 10–3–4. Sweet potatoes yield from 150 to 300 bushels per acre when well fertilized. Pecans do very well on this soil. Cotton yields from one-fifth to one-third bale under ordinary methods of treatment. Cotton fertilizers should run higher in potash and phosphoric acid than those used for the crops just mentioned—about 10–2–8 is a good mixture—and should be applied at the rate of about 500 pounds to the acre and always in conjunction with some form of organic manure. Oats can not be grown very profitably unless fertilized. Cabbage, English peas, and tomatoes do well with heavy applications of manure. The soil is a little too light for best results with peanuts and onions. Good crops of crab-grass hay can be grown.

Fall plowing is not needed, except to turn under green vegetable matter.

The following table gives the average results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Norfolk fine sandy loam.

No.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18856, 18858, 18860	Soil.....	0.6	7.3	8.9	39.5	26.1	11.1	6.5
18857, 18859, 18861	Subsoil...	.9	6.3	5.5	37.3	17.9	9.7	21.9

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ORANGEBURG SANDY LOAM.

The Orangeburg sandy loam is a grayish-brown medium sandy loam, underlain at 10 to 15 inches by a bright-red friable sandy clay. There is generally enough fine material in the soil to impart a moderate degree of loaminess. A small percentage of coarse quartz sand is a prominent characteristic of the subsoil.

The type occupies gently undulating slopes and uplands. The natural drainage is good, while the structure and texture of both soil and subsoil are such as favor the conservation of moisture. Cultivation is possible over a wide range of moisture conditions, without much danger of puddling the soil. Unfavorable structural conditions, however, are likely to follow those methods of treatment which allow the organic matter in the soil to become depleted. As on the Norfolk sandy loam, cowpeas or velvet beans should be grown regularly in rotation with other crops; and occasionally, at least once in three years, a crop of half-matured cowpeas or some other legume should be turned under in late summer or early fall.

The Orangeburg sandy loam is admirably adapted to cotton, peanuts, watermelons, and forage crops, and produces good crops of oats, Irish potatoes, sweet potatoes, and various vegetables. Strawberries would do well on this land.

There is only a small extent of the Orangeburg sandy loam in the county. It occurs in widely separated areas in the northern part of the county.

The following table gives the results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Orangeburg sandy loam.

No.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18872	Soil	6.0	12.1	6.4	35.4	21.9	10.7	7.6
18873	Subsoil	3.1	9.1	4.2	32.4	15.9	7.2	27.7

ORANGEBURG FINE SAND.

The Orangeburg fine sand is a grayish-brown slightly loamy fine sand, underlain at a depth of from 15 to about 28 inches by a reddish fine sandy loam which quickly passes into a friable red fine sandy clay. The color of the clay, although generally bright red, varies from dull red to deep red.

This type of soil occupies stream slopes and rolling uplands. That on stream slopes is quite variable in depth to the subsoil, being generally shallower in the higher positions.

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The greater part of the type is found south of the Ocklocknee River. It is so well drained that crops sometimes suffer from drought, particularly where the organic matter content has been allowed to run low. Susceptibility to crusting following rains is not as noticeable as with the Norfolk soils. Maintenance of favorable structural conditions is aided wonderfully by applications of barnyard manure and by turning under half-matured cowpeas. The growing of velvet beans in rotation with other crops also results in marked improvement of the soil.

With good soil management cotton will yield from one-fourth to one-half bale per acre, corn from 15 to 40 bushels, and oats from 15 to 40 bushels. The average yields, however, are somewhat lower, owing to the prevailing rather indifferent methods of soil management. Cotton suffers sometimes from rust. Potash is a very efficacious fertilizer on the Orangeburg fine sand and should be used in a somewhat larger proportion especially for cotton than on the other soils. The results obtained by the most successful farmers in this and other sections show that a commercial fertilizer analyzing about 8 per cent phosphoric acid, 2 per cent nitrogen, and from 6 to 10 per cent of potash, when applied at the rate of from 300 to 500 pounds per acre, is probably the best form to use for cotton and the general farm crops. Wherever practicable commercial fertilizer should be used in conjunction with organic manure. Nitrogen should be supplied largely by growing leguminous crops, cowpeas, and velvet beans. Watermelons, cantaloupes, and Irish and sweet potatoes do well. Good sugar cane sirup can be produced, especially where the soil is 18 or more inches deep. Sorghum always does well when properly treated. Peanuts succeed on the shallower phase of the type. Very fair Sumatra cigar-wrapper tobacco can be grown on the Orangeburg fine sand where the depth to clay is at least 20 inches. Cuban filler does well, particularly on the shallow phase.

The following table gives the results of mechanical analyses of the soil and subsoil of the Orangeburg fine sand:

Mechanical analyses of Orangeburg fine sand.

No.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18868	Soil	0.3	1.0	0.9	55.4	28.4	7.2	7.0
18869	Subsoil	.2	1.1	.7	48.6	10.4	5.5	33.5

ORANGEBURG FINE SANDY LOAM.

The Orangeburg fine sandy loam is a grayish-brown to reddish-brown fine sandy loam, underlain at 5 to 15 inches by a bright-red friable fine sandy clay. Occasionally the color of the subsoil is a

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dull yellowish red near the line of contact with the Norfolk soils, indicating a gradation between the Norfolk and the Orangeburg series. Generally the deeper the soil the more nearly does the surface material approach a gray color, except in those areas where the red subsoil material has been exposed or washed down from "gall spots" lying at higher elevations. The subsoil sometimes gets quite plastic on the lower slopes bordering streams, approaching here closely the characteristics of the Susquehanna fine sandy loam subsoil.

Small iron concretions occur here and there on the surface and through the soil mass. Such pebbly areas are spoken of locally as "pimply land." These concretions are more commonly encountered in the higher positions, particularly on knolls and the crests of ridges.

The depth to the subsoil on slopes generally increases with the descent, owing to the accumulation of wash material from above. Some areas having a greater depth to the clay than 15 inches (properly Orangeburg fine sand) had to be included with the dominant type on account of their limited extent.

The Orangeburg fine sandy loam is more inclined to wash than the other soils of the county. "Gall spots," or small areas in which the subsoil has been exposed through the removal of the sandy surface soil by erosion, are seen occasionally on the steeper slopes. The susceptibility of the type to wash could be reduced to a minimum by plowing deeper and by incorporating more organic matter with the soil, thus increasing its water-holding power, by having the rows follow the contours of the hills, and by terracing. The fences on this type often catch and hold much material washed against them from above.

While small isolated areas of the Orangeburg fine sandy loam are found here and there in the northern part of the county, the type is confined largely to that part of the county lying to the south of an east and west line drawn through Connells and Wesleyan churches. In its surface configuration the soil usually is gently rolling. The greater part is found on stream slopes, although it not infrequently extends up to and even upon the highest elevations. The largest areas occur along or near the Florida line, south of the Ocklocknee River. Here the country is slightly hilly, but the slopes are smooth and gentle.

The natural drainage of the type is excellent. The subsoil is especially favorable to the maintenance of moisture in quantities favorable to good plant development, and crops suffer very little from drought.

The timber growth is mainly longleaf pine. Hardwoods, such as dogwood, beech, maple, magnolia, and oak, are encountered here and there on the small hammock areas. Ordinarily a hardwood growth is an indication that the depth to clay is less than with the general

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run of the type, and also indicates that the supply of organic matter, the result of leaf-mold accumulation, is exceptionally favorable.

The Orangeburg fine sandy loam is a strong, productive soil, highly adapted to cotton, oats, and forage crops. Corn does hardly as well as on the Norfolk soils, yet enough can be grown easily for all needs of the average farm. Heavy yields of sugar-cane sirup are made, but the quality, especially the color, is generally inferior to that produced on the Norfolk types. Sorghum also does well. The average yields of cotton range from one-third to three-fourths bale; corn, from 8 to 15 or 20 bushels, and oats from 15 to 30 bushels, according to fertilization and the thoroughness of cultivation. Better yields of oats could be secured by sowing in October or November, after a crop of cowpeas or velvet beans. A bale of cotton to the acre can be produced in favorable years with thorough culture.

The best commercial fertilizer for cotton, corn, and oats on this soil, according to the experience of successful farmers, is one that analyzes approximately 10 per cent phosphoric acid, 2 per cent nitrogen, and from 4 to 5 per cent potash. Applications generally should be made at the rate of 300 to 500 pounds per acre for cotton, and from 250 to 350 pounds for corn and oats. Barnyard manure, stable manure, or half-matured vegetation, preferably some legume, should be used in conjunction with commercial fertilizers, for the reason that the effect is generally very much more lasting when used in this way. Cowpeas and velvet beans should be grown regularly in rotation with cotton, oats, and corn. Watermelons, cantaloupes, and cucumbers do very well on the Orangeburg fine sandy loam, and Irish potatoes could be successfully grown where the surface soil is at least 10 inches deep. Where the soil is shallow the potatoes are apt to be soggy and of poor keeping quality. Sweet potatoes do moderately well. Peanuts find the soil very well suited to their requirements.

The Orangeburg fine sandy loam is the best Cuban filler tobacco soil in the area or in this general region. From 500 to 700 pounds per acre can be grown with ease. Sumatra wrapper tobacco can not be grown to best advantage on this soil for the reason that the leaf produced is too thick and heavy.

The following table gives the results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Orangeburg fine sandy loam.

No.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18870	Soil	0.1	0.9	1.1	63.4	23.2	4.5	6.5
18871	Subsoil	.0	.9	.6	38.9	14.6	6.4	38.3

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PORTSMOUTH SANDY LOAM.

The Portsmouth sandy loam is confined to the belt of the coarser textured soils in the northern part of the county, where it occurs as narrow strips along stream slopes and as swales and small basin-like depressions. Some of the lesser bodies were too small to map on the scale used in the survey. The soil is often locally called "black mud land" and "bugle land," the last name on account of the growth of pitcher plants, called "bugles." As the soil is of limited extent in the county and has poor drainage, it is of little agricultural importance.

The Portsmouth sandy loam is a dark-gray to nearly black loamy sand to light sandy loam, underlain at from 10 to 20 inches by a gray or drab sandy loam, which is generally slightly mottled in the lower portion with yellowish and reddish colors. The undrained condition of the soil has favored the accumulation of dark-colored organic matter. The soil material is very much the same as that of the Norfolk sandy loam, the distinguishing characteristics being due to drainage conditions as the result of position. Artificial drainage would be feasible, except in case of some of the small valleylike swales and the deep sink-hole depressions. The stream slope phase often has a substratum of very stiff, impervious mottled clay, which makes the soil rather springy or soggy and which is further objectionable for the reason that it offers a decided obstacle to artificial drainage.

Well-drained areas, especially where the subsoil is a sandy loam and not too plastic or impervious, would produce fair crops of cotton, corn, rice, and sugar cane, while some vegetables, for instance celery, probably would succeed.

The following table gives the results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Portsmouth sandy loam.

No.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18876	Soil	2.9	15.8	13.7	42.2	12.7	7.7	4.6
18877	Subsoil	1.0	8.5	12.3	44.8	12.4	5.1	16.8

PORTSMOUTH FINE SAND.

The Portsmouth fine sand consists of a very dark-gray to black slightly loamy fine sand, underlain at from 15 to 20 inches by a light-gray to drab fine sand, sometimes mottled in the lower portion with yellowish and reddish colors. The subsoil is ordinarily saturated and quite compact, tending when exposed in excavations to flow from beneath the firmer surface soil. This "quicksand" subsoil

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makes it very difficult to effect drainage with open ditches as they quickly fill with this sand.

The soil is sometimes locally referred to as "black mud land." The greater part occurs as very poorly drained flat stretches. It supports a good growth of longleaf pine, some "slash" pine, a large undergrowth of gallberry bushes, scattering palmetto, and often "bugles." There are small strips along stream slopes here and there and occasionally patches are found in basinlike depressions. There is a low, flat body of considerable size west of Spring Hill Church, near the county line. The largest areas are found along the Ocklocknee River at an elevation ranging from a few feet to about 30 feet above the river "flats." A typical area is the one just south of Pine Park Station.

None of the Portsmouth fine sand is under cultivation, and extensive ditching or tiling would be necessary before any agricultural use could be made of it, unless it be the production of rice. With good drainage it is probable that sugar cane, Irish potatoes, onions, and corn could be grown. Experience with this same soil in other sections has demonstrated the fact that the organic matter is exhausted rapidly under cultivation despite the present high organic matter content. The turning under of green crops of cowpeas, velvet beans, or other vegetable matter would be necessary to maintain even moderate productiveness. The use of lime in conjunction with green manures such as those mentioned would prove beneficial for this character of land.[a]

The following table gives the results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Portsmouth fine sand.

No.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18874	Soil	0.1	2.1	3.0	49.7	30.3	12.5	2.1
18875	Subsoil	.2	1.8	2.5	58.7	24.9	9.3	2.3

PORTSMOUTH FINE SANDY LOAM.

The soil of the Portsmouth fine sandy loam is a dark-gray to black very fine sandy loam averaging about 12 inches in depth. The subsoil, usually a light-gray or drab or a mottling of these colors with yellow and reddish yellow, averages a moderately heavy fine sandy loam, usually compact and saturated in the lower portion. In the

[a] Soil survey of the Waycross Area, Georgia, page 303. Field Operations of the Bureau of Soils, 1906.

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higher lying, better drained situations the subsoil sometimes is quite uniformly yellow.

The type occupies flat to gently undulating uplands, stream slopes, and low, flat situations above the heads of streams. It is also found in numerous small sink-hole depressions and swales. That found about the heads of streams and on stream slopes is usually springy and remains water-logged throughout the year. The deep subsoil here is often a stiff, impervious, mottled drab and yellow, sandy clay. The disadvantage of this impervious underlying material, coupled with the further objectionable feature of seepage from above, practically precludes the possibility of good drainage in such situations. In the depressions the soil is generally more loamy than the average, and is always quite wet. Here also the subsoil frequently is a stiff, mottled drab, sandy clay. Cypress, black gum, and mayhaw are common to these depressions, especially where water stands throughout a good part of the year. Longleaf and "slash" pine constitute the usual timber growth on the other areas. Gallberry is very abundant everywhere, and palmetto and pitcher plants, or "bugles," are especially common on the poorly drained areas.

Considerable areas of the Portsmouth fine sandy loam are found throughout the northern part of the county. In the northwestern part there are a number of areas occupying the low, flat situations common to this section.

Very little of the soil is under cultivation. Much of it could be drained by means of open ditches and be made to produce rice and sugar cane and possibly fair crops of corn and strawberries. However, it is not likely that any of this soil will be used for agricultural purposes in the near future in view of the fact that there is available so much well-drained productive land throughout the county.

SUSQUEHANNA FINE SANDY LOAM.

The Susquehanna fine sandy loam occurs in several phases, differing mainly in topography and depth to subsoil. A slope phase is found in narrow strips along the lower slopes bordering stream bottom land. Here the soil depth is quite variable, depending largely upon the position and the steepness of the slope. From the higher positions on steep slopes not infrequently the soil portion has been washed off, leaving a stiff clay exposed or very near the surface. Where the slope is not so steep the material removed from above has been deposited lower down, so that the depth to subsoil usually increases toward the stream, the accumulation sometimes being deep enough to warrant classification of the surface material as colluvial Norfolk fine sand. The soil here consists of a dark-gray to dull-brown fine sandy loam, while the subsoil generally is a plastic, putty-like sandy clay, mottled pinkish red, yellow, and drab. Sometimes

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the upper portion of this subsoil is distinctly yellow, and occasionally this yellow color persists to a depth of about 3 feet, but a stiff, mottled clay is always encountered somewhere below. Greenish yellow to nearly white material resembling fuller's earth is found in places, generally below the mottled clay. Fragments of rotten limestone are also seen in the subsoil of some of the areas.

These narrow strips of Susquehanna fine sandy loam, found here and there throughout the county, are usually spoken of locally as "pipe clay land." The original timber growth consists principally of beech, dogwood, oak, and pine.

In the Lime Sink and Blowing Cave districts, the Susquehanna fine sandy loam occupies the flat to undulating "slough" country lying from 20 to 40 feet below the general upland level. This phase is a light-gray to dark-gray fine sandy loam running high in silt, especially in the low, flat, situations. There are several small areas in the "slough" lands which in texture approach closely a silt loam and which have dark-colored subsoils. In this section of the county the type is also found in small areas along the slopes of hills. At about 12 inches the surface soil of this hill-slope phase passes into a stiff yellow clay which at a lower depth grades into a plastic clay mottled pinkish red, drab, and yellowish. This subsoil carries more sand than that of the stream-slope phase and in the mottling the reddish color is less conspicuous. Occasionally, however, the subsoil here is quite red, at first sight resembling that of the Orangeburg. In these higher rolling areas fragments of a rather cherty limestone are abundant on the surface and throughout the soil mass. These fragments have been derived from outcrops of the underlying Vicksburg-Jackson limestone formation.

Sink holes are quite common in the flat areas and occasionally streams empty into these as in the Bay Sink and the Lime Sink. It appears that these sink holes have played some part in the formation of these low, flat "slough" lands through increased erosion in the vicinity of such openings into subterranean passages. Large quantities of soil material have been and are being carried off from local areas by these underground streams.

That the subsoil portion of some of this type was derived in part from or has been influenced in some degree by the underlying limestone is suggested by the fact that outcrops of limestone are commonly associated with the type. The soil proper unquestionably is composed largely of either the material that gives rise to the Norfolk types or the material underlying the Norfolk soils.

Where the drainage is good and the depth of soil 10 inches or more, good crops of corn and peanuts can be grown. It is said that cotton is inclined to suffer from black root on this soil. The production of tobacco and potatoes should not be attempted. The removal of sur-

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face water from the flat areas by ditching would be quite effective in the reclamation of such lands for agricultural purposes. In the wet, springy, depressed areas the subsoil is so impervious and stiff that not much improvement can be effected by artificial drainage. The soil is not of sufficient extent to warrant at present any great effort or expense toward reclaiming it.

The following table gives the results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Susquehanna fine sandy loam.

No.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18849	Soil	0.8	8.3	9.1	27.4	22.4	22.7	8.8
18850	Subsoil	.6	8.9	6.3	22.4	11.8	13.3	36.1

CHASTAIN FINE SANDY LOAM.

The Chastain fine sandy loam occupies the broad "river flats" of the Ocklocknee and the stream bottoms of some of the larger creeks. Though varied by hummocks of sand, small outcrops of a mottled red and drab impervious clay, and by depressions containing dark mucky soil, the type consists for the most part of a grayish to dark-gray loamy fine sand to light fine sandy loam, underlain at depths ranging from a few inches to 3 feet or more by an impervious, mottled drab, yellow, and sometimes reddish clay. Probably from 80 to 90 per cent of the soil averages a fairly uniform, very light fine sandy loam. However, the type is less uniform in its textural composition than the other types of the area, and some of the nonconformities would have been separated and mapped if they had been of sufficient importance to justify such detail. The surface generally is flat except for occasional sloughlike and rounded depressions. The impervious clay subsoil is often the undisturbed sedimentary material.

These bottoms vary from narrow strips to areas nearly a half mile or more in width. They are subject to overflow and are generally considered nonproductive. At present they are valuable only for their excellent growth of longleaf and "slash" pine. There is usually present a scattering growth of palmetto and gallberry bushes.

It is probable that the type could be improved for grazing purposes, and with extensive drainage and heavy fertilization could doubtless be made to produce sugar cane and corn. It is not likely, however, that any of this land will be brought under cultivation in the near future for the reason that there is plenty of available, well-drained, productive land throughout the county. Along some of the creeks where overflows are not so serious as in the river bottoms the land could easily be brought under cultivation by ditching.

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GRADY LOAM.

The Grady loam is a dull brown, light-textured loam, underlain at 15 to 20 inches by an extremely stiff bluish-drab clay mottled slightly with reddish and yellowish colors. It is found in a single flat, low-lying body crossing the northwestern corner of the county from Mitchell to Decatur County. Lying from 20 to 30 feet below the general upland level, which is reached through an almost abrupt rise from the marginal boundaries of the type, this flat body of land presents in its meandering direction and varying width a close resemblance to an old stream bed.

The area is known locally as the "Big Slough," for the reason that the waters of the several streams which flow into it from its upper boundaries in Mitchell County to the point where it blends with and disappears into the sandy belt bordering the Flint River,[a] sink into the soil so rapidly that there is a perceptible flow in the direction of the slope to the southwest only in seasons of heavy rainfall. The "Big Slough" is covered by water in wet weather, but this seeps off rapidly in dry seasons, there remaining generally throughout the summer only small ponds of water here and there in the sink holes and swales. Though much water is absorbed by the soil, the greater part probably reaches underground passageways through the sink holes. In several places the limestone, which undoubtedly underlies the entire area, crops out. The soil portion of the type unquestionably consists largely of material washed in from the surrounding upland, but the origin of the subsoil, whether representing sedimentary material entirely or sedimentary material influenced by the limestone, is questionable, but the last-named possible origin seems the most probable one. If there is any lime in the soil it is present only in traces.

Mayhaw and water oak, for the most part, constitute the sparse or clumpy timber growth. The "Big Slough" is famous for its mayhaw berries, which are gathered in large quantities for making a delicious jelly. Under present conditions of drainage the soil is too wet and clammy for cultivation, and on account of the danger of being flooded during heavy rains at any time of the year it is not likely that much headway will be made in its utilization for agricultural purposes until a thorough system of drainage has been installed. At present cattle and hogs find good grazing here during the summer. If drained, alfalfa, corn, grass, and rice undoubtedly could be grown with success.

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[a] The Flint River in this part of the area is peculiar in that it does not receive any surface tributaries of any kind and has no border of low, wet land to mark its flood level. (Field Operations of the Bureau of Soils, 1904, p. 250.)

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With a system of ditches or canals emptying into the sink holes or carried through or into the flat country southward toward the Flint River, it would seem that this body of land could be put in good condition without an unreasonable expenditure.

There are several low, flat stretches of country ("slough lands") in the northern part of Grady County into which the waters of small streams flow and sink, but none of these have as well-defined bottom land and the soils in such situations never show the marked uniformity as does the Grady loam, nor do they appear in any way closely related to the latter type.

The peculiar topography of the "Big Slough" is rather inexplicable, unless it be accounted for by a sinking in of the land overlying a limestone cavity or by intensified erosion in the vicinity of a chain of sink holes.

The following table gives the results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Grady loam.

No.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18845	Soil	1.6	15.8	9.2	22.7	10.2	17.1	23.1
18846	Subsoil	.7	7.9	4.5	10.7	6.3	10.6	59.1

MEADOW.

Under the term Meadow has been included those poorly drained areas found along small streams and in upland swales and depressions. Bordering nearly every branch and creek in the county are found these strips of wet, soggy land, supporting a dense growth of magnolia, bay, "slash" and longleaf pine, maple, black oak, gallberry bushes, and other water-loving growths. The texture of the more truly alluvial phase, although consisting for the most part of sandy material, is so variable that it could not be classified as a distinct type of soil. Some of this bottom land is underlain by a bluish and drab, plastic, "crawfishy" sandy clay, either in the form of lenses interspersed through a sandy matrix or as a uniform substratum. In other places Meadow is merely a soil condition; that is, in the swales along branches often only wet-weather drainage ways, the soil receiving so much seepage water that it is always in a waterlogged condition. In such situations there is always a dense growth of gallberry bushes, and the surface soil is decidedly mucky on account of organic matter accumulations from the dense growth. The subsoil of this springy land is always a clammy, drab or mottled material, varying in texture from sandy clay to nearly pure sand.

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Another grade of Meadow is found in the quasi-bottom lands in the southern part of the county, where in some of the broad valleys and swales deep layers of soil have been deposited by wash from the adjacent uplands. The streams here are small, or really little more than wet-weather drainage ways. The land, especially when ditched, is admirably adapted to the production of corn and oats. Live oak is very common on this soil.

Another grade of Meadow is found in the shallow sink-hole depressions and swales of the uplands which hold water for a part of the year. Such wet places generally support a dense growth of cypress, mayhaw, and black gum, and are often referred to as "cypress," "mayhaw," or "black gum ponds." Some of these areas could be ditched and utilized for the production of corn and rice. The stream depression and stream bottom phases of Meadow would be very hard to drain, and at present none of such land is under cultivation.

SUMMARY.

Grady County is situated in southwest Georgia and comprises an area of 294,080 acres or about 459 square miles.

The topography is flat to gently rolling. Drainage for the most part is good.

The climate is mild, roses and other flowering plants blooming throughout the year, though occasional frosts occur between November 15 and March 1. The summers are long and hot, though modified by breezes from the Gulf, which is only about 40 miles distant.

Transportation facilities are good for a large part of the county. The public roads are kept in fairly good condition.

Sugar cane for sirup, shade-grown and sun-grown Sumatra cigar-wrapper tobacco, Cuban filler cigar tobacco, long-staple cotton, and watermelons are special crops that are proving a success. Irish and sweet potatoes, cantaloupes, and other truck crops are specialties, the production of which could be profitably extended. In addition to the above, the usual staple crops of the South are produced to advantage.

The soils range all the way from loam to loose sand. Their organic matter content is higher and the power to retain moisture greater than in many Coastal Plain sections.

The Norfolk fine sandy loam was mapped in three phases according to differences in crop value, as determined by differences in soil depth. The shallow phase is well suited to cotton, oats, peanuts, and forage crops, but is too heavy for best results with tobacco, corn, sugar cane, watermelons, potatoes, and truck generally. The medium deep phase is the best sugar cane and Sumatra cigar-wrapper tobacco soil of this general region. It also produces good corn, sweet and Irish potatoes, forage crops, and vegetables, and fair cotton. Pecans, pears,

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plums, and grapes do well. The deep phase makes very fair corn, excellent sugar-cane sirup, and various vegetables, but is rather too droughty for tobacco without irrigation. The varieties of cotton grown are inclined to go too much to weed on this phase. All crops require extra heavy applications of fertilizers and manure, especially organic manures.

The Norfolk fine sand is very similar in its crop adaptation to the deep phase of the Norfolk fine sandy loam, but it is a little more droughty and makes somewhat lighter average yields. It is a good vegetable but rather a poor cotton soil.

The Norfolk sandy loam produces very fair yields of a great variety of vegetables and forage crops. Cotton does well where the depth to the subsoil is not over 15 inches, as also do peanuts and potatoes. Sugar cane, corn, and sweet potatoes do best where the surface soil depth ranges from 10 to about 20 inches. Strawberries, cantaloupes, and cucumbers would do very well. A fair to medium grade of wrapper tobacco can be grown where the soil, with a depth of from 10 to 20 inches to subsoil, is of the finer texture. The crop yields on the type average something less than on the Norfolk fine sandy loam.

The Norfolk sand is a loose, rather droughty soil, which requires heavy fertilization, particularly with organic manures, for profitable returns. Crops like half-matured cowpeas should be turned under occasionally to improve the structure of the soil. This is a warm soil well suited to early vegetables. The varieties of cotton grown go badly to weed in wet years and suffer from rust in dry years.

The Tifton sandy loam is the best cotton soil of the county, making with proper treatment from one-half to 1 bale per acre. Heavy yields of sugar-cane sirup are secured, but the color is usually a little darker than that produced on the lighter soils. Corn, oats, and forage crops succeed very well; watermelons, cantaloupes, and sweet potatoes do fairly well. Extra early vegetables can be grown, but as a general rule the type is not admirably adapted to truck crops. Long-staple, or Sea Island, cotton does probably better on this than on any other type, with the possible exception of the "pimply" areas of the Norfolk sandy loam and fine sandy loam, which give about the same results.

The Orangeburg fine sandy loam is admirably adapted to the production of the Cuban type of cigar-filler tobacco. Cotton, Irish potatoes, oats, and forage crops do well. The soil depth should be at least 10 inches for best results with Irish potatoes. Corn, peanuts, sweet potatoes, and watermelons do fairly well. Heavy yields of sugar-cane sirup are made, but often the color is quite dark, especially where the red-clay subsoil comes near the surface. Vegetables as a rule are only moderately successful. Pecans, pears, figs, and plums do well.

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The Orangeburg sandy loam is adapted to about the same crops as the Orangeburg fine sandy loam, but the yields average a little less than those on the latter type.

The Orangeburg fine sand makes very fair yields of corn, forage crops, and truck. The varieties of cotton grown are inclined to go badly to weed in wet seasons and to rust in dry seasons. Sweet and Irish potatoes and watermelons do well. Sumatra-wrapper cigar tobacco does fairly well under shade, where the depth to clay is at least 22 inches.

The Portsmouth soils, owing to their poor drainage, are not cultivated and under present conditions could scarcely be used for the profitable production of any crop. Where the sandy surface material is over 20 inches deep the Portsmouth types would be rather unproductive even though artificially drained. Rice and sugar cane would probably do fairly well on the heavier phases of the fine sandy loam and sandy loam types. It is not likely that the cultivation of any great part of these soils will be attempted in the near future on account of the abundance of other well-drained and productive soils throughout the county.

The Susquehanna fine sandy loam is not an important agricultural soil because of its unfavorable topographic position and the unfavorable structure of the subsoil. Some of the areas, however, make moderate yields of the general farm crops.

The Grady loam is not a very extensive soil, and the present drainage conditions are such as to prohibit its utilization for agricultural purposes.

The Chastain fine sandy loam or stream bottom soil is not used at all for agricultural purposes. It would require thorough artificial drainage and perhaps some diking for its reclamation. Local esteem holds it as soil too unproductive to warrant any attention except for the growth of longleaf pine.

Meadow comprises the undrained wet stream and depressed areas and is used only to a very little extent for agricultural purposes although much of it could be reclaimed so as to produce rice and corn. Some of the broad, better drained areas in the southern part of the county make excellent crops of corn.

The methods of cultivation in general are very well suited to the soils and conditions, especially so in the production of sugar cane, tobacco, cotton, melons, and peanuts. Some improvement in methods, however, might well be made in respect to corn, oats, and truck crops. Fall plowing should be more generally practiced on the heavier types; more organic matter returned to the soil by growing vetch, cowpeas, and velvet beans; and more attention given to crop rotation and to improving the varieties of each crop by proper seed selection. The

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home mixing of fertilizers should be more commonly practiced, and commercial fertilizers, when used, should be applied generally in conjunction with vegetable manures. As grazing can be done the year round on green forage, such as vetch, rape, rye, oats, Bermuda grass, cowpeas, sorghum, and velvet beans, it would seem that the raising of more live stock would be quite profitable; the mere fact of thus having a larger quantity of manure to apply to the cultivated fields should be an important consideration in this connection.

There are good opportunities for the further development of agriculture in Grady County. The soils are adapted to an exceptionally wide range of crops, and suitable land can be bought at very moderate prices. It is safe to say that few sections offer more attractive inducements to the man of small means or to the capitalist desiring to engage in either specialized or general farming.

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SOIL SURVEY OF THOMAS COUNTY, GEORGIA.

By HUGH H. BENNETT and CHARLES J. MANN.

DESCRIPTION OF THE AREA.

Thomas County, Ga., is situated in the southwestern part of the State, on the Florida line, and lies approximately between the parallels 30° 30′ and 31° 10′ north latitude and meridians 83° 40′ and 84° 10′ west longitude. It is bounded on the north by Mitchell and Colquitt counties, on the east by Brooks County, on the south by Leon and Jefferson counties, Florida, and on the west by Grady County. Thomasville, the county seat, is located near the center of the county. It is about 188 miles southwest from Savannah, 206 miles south of Atlanta and 48 miles north of the Apalachee Bay, on the Gulf of Mexico. In areal extent the county embraces 345,728 acres, or about 540 square miles.

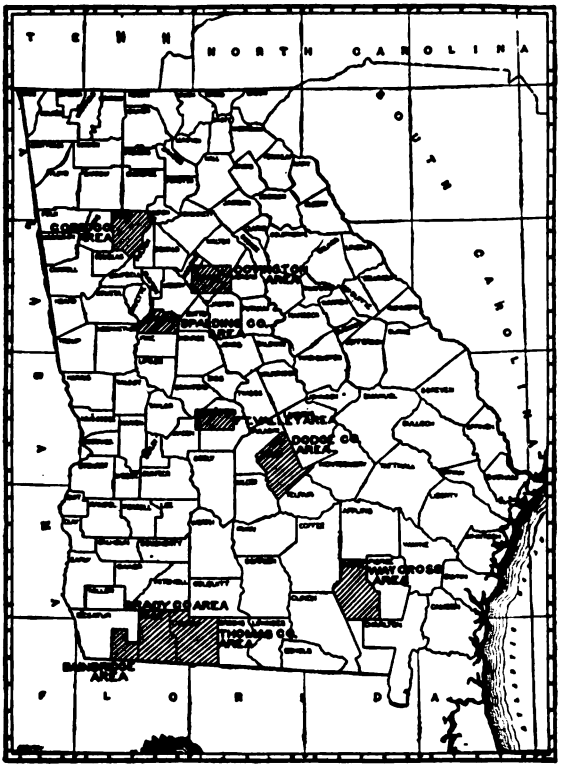

FIG. 9.—Sketch map showing location of the Thomas County area, Georgia.

The base map of the county showing the location of roads, towns, schoolhouses, churches, dwellings, railroads, streams, etc., was constructed with the plane table as the soil mapping progressed, and its scale is 1 inch to 1 mile.[a]

[a] The county was covered by an early survey, by which it was divided into lots of two sizes: Those east of a north and south line located about a mile and a half west of the court-house at Thomasville theoretically have an area of 490 acres, while those to the west of this line are 250 acres in extent. The actual size of some of these lots varies considerably, owing to inaccuracies in the original surveys. Owing to lack of time it was not possible to survey out and show these lot lines on the map.

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The surface configuration of Thomas County is undulating to gently rolling, varied here and there by minor hills, depressions, and rather shallow, narrow valleys. A striking topographic feature is the great number of streams which ramify the county and form an intricate drainage system. Many of these streams in their upper reaches are mere drainage ways or wet-weather streams, and there is usually a conspicuous fringe of hardwood growth along them. From most elevations commanding any considerable view of the surrounding country streams can be seen running off in all directions. Broad stretches of flat and gently undulating interstream country are of common occurrence in the northern part of the area, particularly in the northeastern section, between Coolidge and Pavo. Sink holes occur throughout the county, and in places are so numerous and deep as to give the surface a peculiar billowy configuration. These sink holes are especially well developed upon the flat lands referred to above. Another peculiar but minor topographic feature is seen in an occasional amphitheaterlike excavation about the head of a small stream. It would seem that such peculiar surface dissection must have arisen from the removal of the sides of sink holes by the gradual encroachment of streams. There are several sink holes or "lime sinks" into which streams enter and disappear.

A number of ponds and shallow lakes occur throughout the county. Linton Lake and Heard's Pond are the largest bodies of still water. In the southern part of the county streams have cut deeper and broader valleys, giving rise to fairly well developed interstream ridges or drainage divides, and these are more or less parallel. Here is found the most rolling portion of the county, but even so, the highest elevations are hardly more than 100 or 125 feet above the valley floors. Going northward, surface contours become smoother and the valleys become shallower.

The streams of the county all have unbroken stretches of bottom or "low lands" which vary in width from a few rods to the broad stretches like the Ocklocknee River flats, which are nearly a mile wide in places. These wide bottoms are sometimes flanked on each side by bluffs 15 to 40 feet high. Above these bluffs there is sometimes a flat stretch, sloping away gently toward the main upland level and having somewhat the appearance of a former flood plain or second bottom. In places, however, the low bluffs are entirely lacking and there is a gentle slope upward directly from the margin of the bottom land. The stream meanders through the wide bottom, touching the bluffs here on one side and there on the other. The Ocklocknee River bottoms are overflowed quite frequently. The larger creek bottoms, except where the channels are choked, giving rise to a tendency to divide and form sloughlike streams as in case of the lower Oscillo

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generally, are only partially overflowed under normal conditions of rainfall. The Pine Creek bottoms, in the southern part of the county, for instance, have not been overflowed completely in several years.

There is a gradual though imperceptible ascent in slope from the eastern county line to Thomasville, thence a descent to the Ocklocknee River on the west. From south to north there is a gradual ascent. The elevation at Boston, in the eastern part of the area, is 173 feet, at Thomasville 250 feet, and at Cairo, about 7½ miles west of the western county line, it is 238 feet; the elevation at Metcalf, near the Florida line, is 170 feet, while that at Meigs, in the northwestern corner of the county, is 341 feet.[a] While erosion has played the major rôle in dissecting and altering the surface configuration of the original nearly level plain, much of the surface unevenness such as sink-hole depressions and rounded hillocks with their intervening valleys is due to the "uneven dissolution of the underlying limestones."[b]

There are in Thomas County some extensive bodies of longleaf pine interspersed occasionally with black pine, slash pine, scrub oak, and dogwood. Smaller bodies of "hammock land" supporting a growth of harwood are found throughout the area. Magnolia, beech, dogwood, white oak, red oak, post oak, water oak, live oak, blackjack oak, sandjack oak, hickory, poplar, maple, bay, black gum, sweet gum, several varieties of pine and in wet places a number of water-loving trees and shrubs constitute the principal growth of the various kinds of "hammock land." Stream bottoms may be timbered either with longleaf or shortleaf pine or a growth of hardwood and pine, the last being true generally in case of streams having narrow bottoms and loamy soils. Shallow upland ponds frequently support dense growths of cypress, mayhaw, or black gum, being called according to the growth "cypress," "mayhaw," or "black gum ponds." The turpentine and sawmill industries have exhausted the merchantable timber over large sections of the county.

Wire-grass (*Aristida stricta*) flourishes everywhere on the well-drained longleaf pine lands and affords fair grazing for cattle at certain seasons of the year. Much land is burned over in the spring for the purpose of removing the old dead covering of vegetation so as to give the new grass an early start, and make it easily accessible to cattle.

Thomas County was laid off from Decatur and Irwin counties in 1825 and a part of Lowndes was added in 1826. Portions were cut off in 1856 and 1858 to be included in the formation of Colquitt and Brooks, respectively. About 190 square miles were detached in 1907

[a] Atlantic Coast Line R. R. Survey. Elevation of roadbed at depot above mean low water at Savannah.

[b] Soil Survey Leon County, Fla.

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to form a part of Grady County. Settlement began in Thomas County in the early part of the nineteenth century, but advanced slowly until given an impetus by the opening of the present Atlantic Coast Line Railroad in about 1860. The population of 6,766 in 1840 had increased to 10,766 in 1860. The population according to the census of 1900 was 31,076, and of this number 8,116 lived in towns. Of course these figures have been changed by subdivisions of the county, but they represent the general trend of the increase in population.

The pioneers came largely from the older sections of Georgia. Before the war a number of slave owners came in from other States, seeking new fields for slaves not needed on their old plantations. Since the war a great number of settlers have come in from North Carolina and other southern States. Until recently there were a good many sparsely settled communities in the county, but a number of these, as, for example, Coolidge, are becoming quite prosperous, and unused lands are being brought more and more under cultivation. The construction of the Atlanta, Birmingham and Atlantic Railroad and the Florida Central Railway has stimulated effort along agricultural lines in formerly rather undeveloped sections, and with the construction of other railways more and more land will be brought under cultivation and the population should show a gradual and healthful increase. Thomasville, the county seat, has a population of about 8,000; Boston, Meigs, Ochlocknee, Pavo, Metcalf, and Coolidge are other important towns.

Railroads radiate in six directions from Thomasville. They are Atlantic Coast Line from Savannah to Montgomery, Ala.; the Albany and Monticello branches of that system; the Atlanta, Birmingham and Atlantic, and the Florida Central. The Georgia Northern runs from Boston northward along the eastern county line. Stations along these roads give the county exceptionally good shipping facilities. Fast service is offered to large outside markets. Public roads are generally exceptionally good. The county is rapidly grading, straightening, and putting all public roads into excellent condition.

CLIMATE.

The climate of Thomas County is what is known as "warm temperate." The winters are mild, and while the summers are long and warm they are moderated by Gulf breezes. The mean temperature for the months of October to March, inclusive, is 58° F., the normals for the coldest of these, December, January, and February, being approximately 53° F. Snow falls so rarely that there may be periods of ten years or more without even a flurry. Temperatures lower than

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30° F. are rare, yet thin ice is often formed at night in the winter season. Usually there will be three or four days of cold, bracing weather, followed by about an equal number of warm or balmy days, frequently ending with a rain. The high humidity makes the cold somewhat more penetrating than would the same temperature in a higher altitude. Killing frosts, though erratic, are likely to occur any time between November 20 and March 1. Violets, japonicas, and roses bloom almost throughout the winter, the last blooming profusely nearly every month of the year. The yellow jessamine, dogwood, and wild azalea bloom in early March, while the magnolia and wistaria bloom in April. Vegetables like lettuce, beets, and spinach can be grown with little or no protection during winter, while very early vegetables, like garden beans, snap beans, radishes, and Irish potatoes, can be counted on as reasonably safe from frost after the middle of February. With pine needles or cloth available for immediate use as a covering, there need be but little fear of frosts on the part of those who keep in touch with the Weather Bureau predictions. Cabbage, blackberries, and dewberries seldom are injured by frost.

The mean temperature for the spring and summer months, April to September, inclusive, is 77° F. Temperatures of 100° F. are rather exceptional, although there are days when the temperature goes higher than this. Sunstrokes are almost unknown. The nights are usually made quite comfortable by the Gulf breezes. The rainfall, which is ordinarily sufficient for all crops, is quite favorably distributed throughout the year. The greatest precipitation occurs during the months of June, July, and August, the monthly average being about 6.2 inches. Corn and cane occasionally suffer during dry spells in June and July, particularly on the lighter soils, as the Norfolk sand and fine sand and the deep phases of the Norfolk sandy loam and fine sandy loam. Watermelons sometimes suffer on these soils in May and June. Cotton rarely suffers from drought, but it is not infrequently injured, particularly on these types, from too much rain. Occasionally there are heavy fogs in the morning, but these usually disappear about 10 o'clock.

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The following table shows the meteorological records as kept by the Weather Bureau station at Thomasville, where the climate is quite representative of the country:

Normal monthly, seasonal, and annual temperature and precipitation.

Month.	Temperature.			Precipitation.		
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year.	Total amount for the wettest year.
	°F.	°F.	°F.	Inches.	Inches.	Inches.
December	53	79	13	3.9	2.5	7.0
January	52	81	17	3.5	3.5	3.8
February	54	81	2	5.0	4.1	4.8
Winter	53	.....	.....	12.4	10.1	15.6
March	61	87	22	4.7	3.4	5.4
April	67	92	35	3.6	3.4	5.8
May	74	101	43	3.7	1.3	7.7
Spring	67	.....	.....	12.0	8.1	18.9
June	80	102	48	5.4	6.6	8.8
July	82	106	62	6.8	7.7	4.8
August	81	101	61	6.3	4.3	5.5
Summer	81	.....	.....	18.5	18.6	19.1
September	77	99	46	4.8	0.7	6.4
October	68	97	35	3.4	3.3	2.0
November	59	88	26	2.7	0.5	3.1
Fall	68	.....	.....	10.9	4.5	11.5
Year	67	106	2	53.8	41.3	65.1

AGRICULTURE.

Notwithstanding settlement began in the territory now included in Thomas County in the early part of the nineteenth century, agricultural development had made but little progress until after 1830. The census of 1840 gives the following figures for the important agricultural products for the county, which then included a considerably larger territory than at present: Cotton, 1,565,262 pounds; corn, 149,736 bushels; potatoes, 49,169 bushels; rice, 23,625 pounds; oats, 1,138 bushels; and sugar, 52,445 pounds. Other, but relatively unimportant, products reported were tobacco and silk cocoons. Peas, beans, and potatoes were the important vegetables at this time; and cotton and corn were the staple crops almost from the inception of agriculture in the region.

The raising of stock was an important adjunct to farming. Cattle, hogs, and sheep were allowed to graze on the range the year around without shelter or additional feed, and naturally the breeds became stunted and run down. All land except cultivated fields, which were

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fenced, was considered as open range for stock. The native cane, which grew in abundance along branches, furnished excellent green forage during both summer and winter, but with constant grazing this was soon exhausted, its place being taken by wire grass and broom sedge.

At first "hammock land" was considered as being the only land fit for cultivation. The limited extent of this, however, together with the constant cropping without applications of manure, soon reduced the crop yields to such an extent that cultivation was necessarily extended to the longleaf-pine forest or "piney woods" lands. The "piney woods" land, though not as productive as new hammock, proved quite satisfactory, as did also the "pimply," or gravelly lands, which, in some sections, were long considered as worthless. These "pimply" soils, after the first attempt, were and are still considered as the best cotton soils of the region.

Until about 1840 farms were generally self-sustaining, except as to draft stock. About this time cotton became almost the sole crop grown on the big plantations. After the war home supplies were high, there was little demand for cotton, and the labor could not be controlled. In consequence of this many large holdings were divided and either sold to small farmers or rented to tenants.

The agricultural development of Thomas County has been slow. According to the census, during the period 1849 to 1879 very little progress was made. In 1859 there were produced in Thomas County 6,582 bales of cotton and 337,675 bushels of corn. The live stock was valued at $360,249. The corresponding figures for the year 1879 were 8,773 bales of cotton, 245,531 bushels of corn, and value of live stock, $336,910. Following this period there came a gradual improvement. For the year 1889 there were produced 12,763 bales of cotton and 374,500 bushels of corn, while live stock was valued at $437,870; and for the year 1899 the figures were: Cotton, 10,252 bales short staple, 594 bales long staple; corn, 549,780 bushels; the value of live stock had increased to $488,814.

The production of long-staple cotton seems to be rather at a standstill, or perhaps on the decrease. The biggest crop of long staple was that of 1903, which amounted to 985 bales; the largest short-staple crop was that of 1904 and equaled 20,825 500-pound bales. Within the last twenty-five years the production of sugar cane for sirup has increased rapidly and has become one of the most profitable crops grown. The production for Thomas County increased from 165,717 gallons in 1889 to 361,463 gallons in 1899, since which time the acreage has been increased annually. Considerable rice was grown in the early days, and the census reports show that as late as 1899 Thomas County produced 109,242 pounds of it. The production of

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this crop has fallen off so rapidly that at present practically none is grown.

About twenty-five years ago, during the "Le Conte pear craze," thousands of pear trees were sent out over a large section of "south Georgia," including Thomas County. When the orchards came into bearing there were tremendous crops with but little demand; and this unfortunate condition, together with the pear blight which soon followed, discouraged the farmers and caused them to neglect or cut down their orchards. Lately Le Contes gathered in June or July have been bringing fancy prices and those who allowed their trees to stand are making good profits on the crop.

Within the last ten or fifteen years pecans have become popular throughout this region and many trees have been set out and several nurseries started. It is believed the crop will prove successful and profitable.

Tobacco has been tried in Thomas County with rather unsuccessful results several times. Before the war "Florida tobacco" was grown by a number of planters. Some ten or fifteen years ago Cuban filler tobacco was grown quite extensively and considerable money was lost in the enterprise. The first crop proved profitable to a number of farmers, whereupon there was a general rush into the business without thought of market demands for this grade of tobacco and with far too little understanding of the proper methods of handling the crop. The failure of the attempt so discouraged the growing of tobacco that the crop was abandoned entirely and there has since been but little effort to establish the industry upon a substantial basis.

A crop of Sumatra cigar-wrapper tobacco was grown under shade in Thomas County in 1907, when a leaf of excellent quality was produced. Very little of this tobacco is grown at present, but whenever market conditions become more favorable this is an industry which may be profitably developed.

Nearly all crops suited to this latitude of the coastal region can be grown successfully in Thomas County. The principal crops at present are cotton, corn, sugar cane for sirup, watermelons, sweet potatoes, oats, peanuts, velvet beans, cowpeas, and pears, besides a great variety of vegetables and fruits for home use.

The long-staple, or Sea Island, variety of cotton is produced on a comparatively small scale at present, not because of poor yields, but rather because of its longer growing season and the fact that it requires much more cultivation and care and is more troublesome to pick than the short-staple variety. Complaint is made in some instances that the price received for the product is not commensurate with the efforts required in its production as compared with the short-staple variety. It is generally conceded that new seed should be

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secured from the Sea Islands or coast regions at frequent intervals in order to preserve its vitality and keep it true to type. The only alternative is to practice careful seed selection.[a]

Cotton does best on the Tifton sandy loam, the "pimply" areas of the shallow phases of the Norfolk fine sandy loam and sandy loam, and on the Orangeburg fine sandy loam. The plant goes too much to weed on the deep sandy soils, especially in wet years. Many farmers are quite careful in selecting their cotton fields, but the crop is grown more or less on all grades of well-drained upland throughout the county. The yields of short staple generally run from one-fourth to one-third of a bale an acre, but with careful soil selection and judicious management could be made to range from one-third to 1 bale an acre. The yield of the long-staple cotton, ordinarily somewhat less than that of short-staple, comes nearer to that of the latter variety on the "pimply" lands, especially the Tifton sandy loam, probably for the reason that these types usually maintain more favorable supplies of moisture throughout the growing season.[b] According to the census, the acreage yield of short-staple cotton for Thomas County in 1899 was 0.35 bale, while that for the State was 0.38 bale.

Cotton is planted on ridges from 2½ to 3½ feet apart. These ridges are prepared either by rebedding (listing on the middles of old rows) or bedding up flat broken land. Sometimes the old beds are plowed out, then later turned back to the original position—a double bedding process which amounts to quite thorough breaking. Planting is often done on quite narrow ridges thrown up with two or three furrows, such ridges being brought up to the usual size by later plowing out the remainder of the old bed. The plan of flat breaking before bedding is generally the best, and the earlier it is done the better. Soils except the sands and deep phases of the sandy and fine sandy loams should be broken in the fall, when possible, to a depth of from 5 to about 8 inches.

The first cultivation consists either in running close to the plants on both sides with a small shovel, or in "barring off;" that is, throwing a portion of the bed toward the center of the row with a "dixie" plow. The last plan is quite effective for covering grass in the middles, especially in wet seasons. The plants thus left on narrow ridges are chopped out to a stand of one or two stalks at intervals of from 6 to 12 inches. The cotton is now run around with sweeps or shovels, the first furrow being close enough to throw dirt up to the

[a] Farmers' Bulletin No. 302, U. S. Dept. of Agriculture.

[b] Sea Island cotton requires more moisture than Upland cotton. Both the quantity and the quality of the staple depend upon the supply of moisture. In dry years the staple is poor, while in wet years it is good. (Bul. 95, Bureau of the Census, p. 19.)

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plants, after which, with one to three furrows, the middle is completely plowed out, leaving the plants on a rounded bed. After "plowing out" each row from three to five times, according to weather and grass, and hoeing frequently to remove grass from the crest of the ridge, the crop is "laid by" about the last of June.

On the "hard pimply lands" cultivation is necessarily quite shallow on account of the resistance offered by the iron gravel. This more nearly flat cultivation gives excellent results on these types, but is not particularly necessary on other types, except in so far as the shallow cultivation of the more nearly flat method assists in conserving moisture. In the case of those flat, heavy soils which sometimes become quite soggy for lack of good surface drainage, it is necessary to grow all crops on ridges, so as to give the plants the advantage of the better drainage afforded by being placed slightly above the level of the field.

Considerable trouble is had in some sections with cotton wilt or "black root." Injury from such diseases seems more common on those areas where the clay comes near the surface, as in case of eroded soils. Such diseased land should be broken deep in the fall, then cultivated to other crops than cotton for a period of two or three years. A good rotation is: Corn with velvet beans, then oats, followed by sweet potatoes. Certain varieties of cowpeas sometimes suffer from a root-knot disease which it seems can increase the damage done to cotton.[a] Cowpeas therefore, unless it be the Iron variety, which is resistant, should not be grown in rotation with this crop on such affected fields. Cotton often suffers from rust on the deep sandy types, but by keeping these well supplied with organic matter, as can be done by growing velvet beans and cowpeas in rotation with corn, cotton, and other crops, and by using barnyard manure and fertilizers high in potash and phosphoric acid, danger from this source could be largely diminished.

Practically nothing is done in the matter of selecting seed from the most productive stalks, notwithstanding improved varieties are being introduced constantly. These varieties procured from outside sources are grown indiscriminately on all types of soil, with the result that oftener than otherwise no particularly good results are secured. If farmers would make a thorough investigation as to the exact character of the land upon which improved varieties have been developed, and buy only seed that has been developed upon land similar to that which they own, much better results would come from the use of imported seed. A variety of cotton bred upon a stiff clay soil in central Georgia would hardly grow successfully on a deep, dry, sandy soil in Thomas County. Much improvement would result from

[a] Bul. 142, Office of Expt. Stations, U. S. Dept. Agr., p. 142.

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persistent effort at breeding cotton at home. Ten years spent in breeding up a variety by selecting and replanting seed from the most productive plants should not be considered a long period in breeding. The same applies in a general way to corn and oats.

In the preparation of the corn ground two methods are commonly used. According to the first the ground is well prepared and thrown up in ridges, and the corn is planted upon these. By the other method the ground is not plowed at all, but the corn is dropped in the water furrow of the preceding cotton or corn crop and covered with two light furrows. When planted on ridges the crop is cultivated about the same as cotton, though not as intensively. When planted in the furrow, or in the streaking-off furrow in flat-broken land, cultivation is delayed until the stalks are large enough to be plowed without being covered up, and as a result the middles often get quite grassy, and not infrequently the plants are injured by water standing in the gutterlike furrow. This method in effect is somewhat similar to the Williamson plan of corn culture, that is, the plants are stunted at first for the lack of good cultivation. The greater part of the corn crop is grown in rows from 4 to 6 feet apart, with a row of peanuts between. This practice originated in the belief that the same yield of corn could be made on the land as when cultivated only to corn. The peanuts are planted soon after the corn is up, and are cultivated about the same way as corn. Some farmers prefer to grow them alone. Peanuts are grown solely for hogs, and after the corn is harvested the hogs are turned into the field, where they make a rapid and healthy growth. Most farms are self-sustaining with respect to corn, but very little of the crop is sold. The average yield is far below what it should be. From 15 to 20 bushels an acre is accounted a good crop, while 30 bushels is considered extraordinary. With the best methods of preparing the land and with proper rotation and fertilization, yields of from 20 to 40 bushels should be regularly secured during average seasons. The deep phases of the sandy and fine sandy loam types, except those of the Portsmouth series, are much better suited to corn than to cotton, and produce better average yields of corn than do the heavier soils. Weevils are quite destructive to corn after housing. The carbon bisulphid treatment properly carried out is a quite effective remedy against this pest.[a] Hard, flinty, weevil resistant varieties need to be introduced and bred up if possible.

Oats are grown according to both the broadcast and open-furrow systems. Broadcast-grown oats usually are sown by hand on unbroken land, plowed under, and left without harrowing on a rough, ill-prepared seed bed to struggle for existence. The land should be broken

[a] Farmers' Bulletin 145, U. S. Dept. Agr.

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and harrowed thoroughly and then seeded by harrowing in the broadcasted oats or by drilling in. According to the open-furrow system the seed are covered shallow in furrows laid off at a distance of about 15 to 24 inches apart. Very good yields of oats are made under this system, especially when given shallow but frequent cultivation. Occasionally peanuts are grown between the rows of oats.

Notwithstanding that the best time for seeding oats is in October or November, in order that the plants may get well started and thus be more resistant to the stunting effects of dry, hot spring weather, the crop is largely seeded in late winter and early spring. The crop is either mowed or harvested with cradle or reaper and is largely used on the farm without thrashing. Oats could be used to good advantage as winter cover crops on slopes subject to washing and they could also be grown more extensively for grazing purposes, especially for hogs and cattle. The rust-proof varieties should be grown. The crop does best on the Orangeburg fine sandy loam and the shallow phases of the Norfolk sandy loam and fine sandy loam. Sown after velvet beans, using a moderate quantity of barnyard manure, fair crops can be produced on all the well-drained soils.

Velvet beans, like peanuts, are grown on ridges between corn rows and in the rows with corn, and also in fields by themselves. They are cultivated about the same as corn. The crop makes such a rank growth that it is a very difficult matter to harvest corn grown with them and it is nearly impossible to harvest the beans for hay; therefore they usually are utilized for fall and winter pasturage. As a forage crop velvet beans are excellent for all kinds of stock, particularly hogs. The crop improves the land wonderfully, not only by storing nitrogen in the roots and replenishing the soil with healthy organic matter, but also by shading the soil, which also improves its tilth, through a proper adjustment of moisture conditions. In consideration of the ease with which they are grown, their fitness in good rotations, their beneficial effect upon the soil, and their excellence as forage, velvet beans merit much greater attention, particularly on deep sandy soils and those lands that have been abused. The crop is successful on all well-drained soils.

Cowpeas generally make an excellent growth of vine on the Norfolk and Orangeburg soils. Sometimes, however, the crop fails to produce seed on the deep sandy soils, especially in wet years. The late crop, that planted in late June and July, usually fruits better. Velvet beans should be grown instead of cowpeas on such areas as are affected with cowpea wilt or root rot. The Unknown, Iron, and Crowder cowpeas are quite successful. It is said the Iron variety is practically immune to root knot.[a] Generally the crop is grown either

[a] Farmers' Bulletin 302, p. 18.

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in rows by itself or is sown between the rows of corn at the last cultivation of the crop. Cowpeas afford excellent pasturage for hogs and cattle and the hay properly handled can not be excelled. The practice of sowing them broadcast for hay could be extended profitably, as the hay baled brings a good price. The vines cut at the stage when about half the pods are ripe can be easily cured.

Cowpeas, like velvet beans, improve the land wonderfully. These crops can be substituted for each other in several good rotations that should be followed. A good scheme of crop succession is to follow velvet beans or cowpeas with corn, then fall-sown oats, followed in the spring by cowpeas or sweet potatoes, and by cotton the next year. Such a scheme can be changed in detail to suit the conditions, it being only necessary to crop land in such a way as to return an abundance of organic matter to the soil and to prevent the soil getting into bad tilth, as often results from continuous or long cultivation to one crop. An occasional crop of cowpeas plowed under when about half mature is markedly beneficial to soils that have deteriorated. An acreage application of from 25 to 40 bushels of lime in conjunction with green manure assists in the conversion of such vegetable matter into humus.

Under the system of farming where cotton, corn, cane, and peanuts are the principal crops, as a rule such little attention is paid to rotation and the humus content of soils that in about ten to fifteen years after clearing the land often gets into an apparently lifeless condition conducive of soil crusting and consequent susceptibility to drought. With such soils deep fall plowing should be practiced. The Orangeburg sandy loam and fine sandy loam and the shallower phases of the Norfolk sandy loam and fine sandy loam in particular should be plowed as early as possible in the fall to a depth of from about 6 to 10 inches, turning to the surface a small portion of the heavy subsoil where possible. Grass, cotton, and cornstalks are often burned during the spring or when the land is being cleared of litter prior to breaking. All refuse vegetation should be incorporated with the soil early enough to undergo decomposition before planting. The practice of resting land occasionally, while better than continuous cultivation to cotton or corn, is a defective system in that it is generally better to have land cultivated to some catch crop or legume than occupied with noxious weeds.

In 1899 expenditures for fertilizers in Thomas County (which then included a part of Grady County) amounted to $57,860. Since that time there has been a gradual increase, and it is likely there will be an annual increase in the quantity used for some time to come. Cotton and corn are nearly always fertilized. The ordinary grades of commercial fertilizers having an average analysis of about 8–2–2[a]

[a] Eight per cent phosphoric acid, 2 per cent nitrogen, and 2 per cent potash.

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are applied indiscriminately to all soils alike. From 200 to 400 pounds for cotton and from 150 to 250 pounds for corn are about the average applications. The fertilizers are distributed and listed upon before planting. Green cotton seed is quite extensively used as a fertilizer. The seed are often turned under and allowed to come up, it being claimed that as good results are had with a large percentage of sprouted seed as when the seed are killed before use. It is the practice of some to put the seed in before the ground warms up in the spring, so that the seed may be killed. The best practice is to use the cotton-seed meal, which carries practically all the fertilizing value of the seed; but in those cases where distance to market makes it an economic necessity to use seed for fertilizer they should be either killed before distributing or they should be plowed under sufficiently early to prevent sprouting. An excellent fertilizer is made by composting cotton seed with barnyard or stable manure, or these together with acid phosphate and kainit.

A good many farmers mix their own fertilizers—a practice thoroughly in accordance with modern methods of farming. Cotton-seed meal, kainit, and acid phosphate or bone meal can be mixed easily on the farm so as to make the mixture correspond with the percentage grades of fertilizers given under the heads of the several soil descriptions.

Oats and peanuts are very rarely fertilized, notwithstanding they would in most instances be materially benefited by acreage applications of about 250 pounds of the grades of fertilizers commonly used for cotton and corn. Commercial fertilizers when used should always be applied in conjunction with some form of organic manure, for the reason that the effect is better and more lasting than otherwise, especially when the soil is deficient in organic matter.

Both the disk and large turning plows can be used with ease upon the soils of the county; but few of the former are in use. Very few cultivators are used, although they could be employed to good advantage in the growing of cotton, corn, and sweet potatoes. The flat style of plows, sweeps, and scrapes in common use are well suited to the soil conditions, especially in dry season, for the reason that they allow a portion of the disturbed soil to fall over the plow so as to form a moisture-protecting mulch in the furrow. The general run of the soils requires frequent shallow cultivation to keep the surface soil well mulched and to break crusts formed by rains. In dry seasons the weeder is an effective implement in the destruction of weeds and soil crusts, especially in cross cultivation of young corn. Not much trouble is had with plowing too wet; however, care must be taken with the heavier soils, as they will puddle if disturbed anywhere near the point of saturation.

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During the winter months many fields could be greatly improved by the use of the stump puller and by burning up or hauling off all old logs, limbs, and stumps.

Beggarweed can be successfully grown on the well-drained types. It makes a nutritious hay and improves the land, but only a small acreage is grown. Sorghum also succeeds on the well-drained upland soils and affords excellent summer pasture for all kinds of stock, being especially satisfactory for sheep and hogs. It comes in very timely to supplement failing midsummer pastures.[a] Crabgrass grows luxuriantly in wet seasons and makes good hay if cut while in bloom. This grass is never sown, being indigenous and very prevalent on all the well-drained soils. Good yields are frequently secured after a crop of melons. Crowfoot grass and sandspurs are other valuable hay grasses. Bermuda grass does well on well-drained soils and withstands summer heat and drought better than any other grass, and besides affords good summer pasturage. It is easily propagated and good stands can be secured by scattering a few bunches of sod here and there and then cultivating the field to cotton or corn so as to distribute the grass over the field.[b]

Crimson clover has been successfully grown on the shallow Norfolk soils, but its production has been attempted more as a novelty than for profit. Lespedeza (Japan clover) affords good grazing in some sections, and seems to be spreading over the area quite rapidly as a wild plant. Velvet beans afford good grazing until late in the season. English rye grass makes a beautiful winter lawn, but dies with the advent of dry, hot weather. Winter vetch could be grown advantageously, particularly on the well-drained shallow soils, for early spring grazing. Alfalfa probably would not prove very successful in this region without liming, soil inoculation, and fertilization. Inoculation can be done by incorporating about 500 pounds of soil taken from a successful alfalfa patch.[c] The only alfalfa seen growing was cultivated in rows about 20 inches apart. The shallow Norfolk and Orangeburg fine sandy loams are best suited to the crop. Chufas can be grown very successfully as a root forage for hogs. Wire-grass and broomsedge when young afford good grazing for

[a] Sorghum may be fed green to all kinds of stock, even to poultry, with very profitable results. A full feed should not be given at first, particularly if the animals are hungry. It is a good practice to give first a light feed of grain or other food and then a small amount of the sorghum. The latter may be increased day by day until a full feed is reached. Fresh sorghum is a very succulent forage and, like clover, is liable to cause bloating when fed in too large quantities at first. With ordinary precautions no trouble from this source need be feared. (See Farmers' Bulletins 246 and 288.)

[b] For further information upon the proper methods of growing and handling Bermuda grass, see Farmers' Bulletin 102, p. 10.

[c] Farmers' Bulletin 215.

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cattle and sheep. The forests and old fields are burned over annually to get these grasses started and to remove obstructing vegetation in order that stock may graze it conveniently. Notwithstanding that a great abundance of forage can be produced easily farmers sometimes buy hay; and occasionally the section is referred to as not being suited to stock because it "is not a grass country." As for securing excellent feed for all kinds of stock very few sections are more favored. Stock can ordinarily be pastured nearly the year round. Beginning with rye and oats in the spring and following with sorghum, cowpeas, velvet beans, peanuts, vetch, ruta-baga, and rape, hogs and cattle can have a succession of excellent green feed throughout the year. Some farmers claim that pork can be produced at a cost of 2½ cents a pound. Fed according to the above succession of crops and fattened on corn and sweet potatoes the production of pork on a very much larger scale could be carried on upon a profitable basis. A number of farmers sell dressed pork at quite remunerative prices.

The common breed of hogs, while well adapted to the prevailing conditions, is rather too inferior a type for best results. The animals too often are forced to look out for themselves until after the corn harvest, when they are turned on to peanuts. They fatten readily enough on this feed, but a more gradual growth the year around, as would be made if regularly well fed, would develop a much better animal. Running streams should be included in hog pastures where possible. Cattle are rarely fed for dairy purposes or for beef, but generally are turned loose to graze in the forests and unused fields. There are two well-kept dairies at Thomasville. The quantity of good milk throughout the county, however, is not enough to supply the demand.

Better breeds of both hogs and cattle are gradually being introduced and mixed with the old stock. A considerable number of sheep and goats are raised, but are given little care.

Farm tenure varies considerably. In the southern part of the county a large majority of the farmers are negroes, who rent "one-horse" and "two-horse" farms, including from 35 to 40 acres to the horse. They grow cotton almost exclusively as a money crop, usually paying a rental of one 500-pound bale of cotton per horse. In other parts of the county about 60 per cent of the farmers manage their own farms, in many cases solely with the assistance of their families. There are a good many "half-croppers," who pay one-half the fertilizer bill and a rental of one-half the staple crops produced for the use of the land, tools, stock, and stock feed.

The systems of renting in vogue are not generally conducive to the betterment of soil conditions, but rather the reverse. During the winter there is considerable moving on the part of renters,

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many of whom seek new locations merely out of a desire for a change. This migratory class rarely accumulate property.

The farms range in size from a few acres to large plantations. The average size, however, is about 110 acres. In the vicinity of Thomasville large tracts of land are held by winter residents, and upon these very little farming outside of gardening is done. The high wages paid by the turpentine and lumbering industries have attracted much of the labor that was formerly available upon the farms, so that the problem of obtaining farm labor has become a very serious one.

Labor-saving farm implements are coming into use, though rather slower than the conditions warrant. Much labor could be saved by a more general use of stump pullers, cultivators, disk plows, harrows, weeders, and mowing machines.

It has been so easy to make a living in Thomas County that farmers generally in the past have been quite conservative and often have not exerted themselves strenuously in the accumulation of property. However, the standards of living are improving and diversification is becoming more popular, and farmers are getting interested in studying the individual needs and the exact crop adaptations of their soils and better methods of soil management. The rural free delivery of mail has helped to inculcate among farmers a greater interest in affairs outside their immediate neighborhoods and has caused them to think more of their agricultural relationship and the value of their products to other sections of the country.

In some sections, as in the neighborhoods of Pavo and Ochlocknee, efforts formerly given almost entirely to cotton lately have been divided between this crop and the growing of sugar cane for sirup. On account of the large acreage of land well adapted to both the Sumatra wrapper and Cuban filler types of tobacco it is likely that in time considerable attention will be turned to these crops.

The county offers extremely attractive inducements to the man of small capital or to the thrifty, ambitious man who is willing to borrow and work. At this time the best grades of land can be bought at from $10 or less to $15 an acre, according to location. In many instances land is held at higher prices on account of its timber, valuable for turpentine and lumber.

SPECIAL INDUSTRIES.

TRUCKING.

While there is a large acreage of land highly adapted to vegetables, trucking has not made any great headway outside of the watermelon industry.

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Thomas County is probably the largest watermelon producing county in the United States, there being under ordinary seasonal conditions something like 1,000 carloads shipped annually. The crop is grown for market on a large number of the farms situated within 5 or 6 miles of the railroad. There is a large acreage of land highly adapted to the crop. The well-drained medium and deep phases of the Norfolk fine sandy loam and sandy loam and the Orangeburg fine sandy loam and fine sand are the best melon soils. The "pimply" areas of these and the Tifton sandy loam make an extra early melon. The Norfolk fine sand and sand are used quite extensively, but the crop is apt to suffer severely on these soils during dry spells. With moderate fertilization the average yield is about one-half carload an acre.

In the cultivation of watermelons the ordinary method is to break the land flat to a depth of 4 to 6 inches, check off so as to bring the hills from 10 to 12 feet apart each way, list on the fertilizers applied either in the drill or in the hill, and plant on the ridge thus made. Land could be brought into better condition generally by breaking in the fall to a depth of 8 inches with a later rebreaking in February. Planting begins about the first of March. It is the rule to plant fields over three or four times at weekly intervals so as to insure against possible damage from late frost. Cultivation is done in one direction first with a "dixie" or turning plow, throwing the dirt toward the vines, until the middle is plowed out. Later plowing is done with sweeps. Care should be taken not to disturb the vines, and when they have spread to such an extent as to limit cultivation to the center of the rows, the hoe should be used to cut out grass and weeds near the hills. In the cultivation of the crop, if the tendrils are broken the vines are blown about by the wind and the development of the plant is retarded.

The most effective fertilizer is stable or barnyard manure or cottonseed manure compost, used at the acreage rate of from 5 to about 10 tons, according to condition of the soil, in conjunction with 500 or 600 pounds of a fertilizer analyzing something like 10–3–4. The ordinary melon fertilizer runs about 8–2–2 in analysis. There is a difference of opinion among growers as to whether manure should be applied in the drill or concentrated about the hill. In view of the fact that the watermelon feeds over a considerable space and, under the prevailing practice of spacing, is quite able to reach the effects of all fertilizer between the hills, broadcasting with heavy applications of fertilizing material is recommended, for the reason that too heavy concentration in the hill often causes "burning," especially on the deep sandy soils.

The Kolb Gem, the Triumph or Blue, and the Rattlesnake are the standard shipping varieties of melons. The melons of better quality,

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as the Thomas, Pierson, and others, are grown only for home use for the reason that they do not stand shipment well on account of their thin rinds. From 800 to 1,200 melons are shipped in a car, where they are piled one upon another, with only a bedding of straw on the car floor.

A number of farmers contract with local buyers or agents of commission houses at about $40 to $50 f. o. b. Extra early melons sometimes bring from $100 to upward of $150 a car. The crop is quite profitable in years of normal yields, but an overproduction or a sudden ripening of a large part of a crop on account of dry weather occasionally reduces the price below the point of profitableness. Usually this is a profitable crop when handled through reliable marketers. The practice of shipping melons to a distant commission merchant and awaiting returns has become unpopular, and they are now largely sold for cash f. o. b. to traveling representatives of commission houses.

On account of the watermelon wilt, which affects a succeeding crop of melons, the same field should not be planted to this crop more than once in from five to eight years, but most other crops can be grown directly after melons. Fields receiving the drainage water from a watermelon patch may thus become affected, and even stock may carry the disease through the medium of dust from one field to another. All vines should be removed or burned as soon as possible after melons are gathered and hogs turned in to clean up the refuse crop where there is danger of spreading the disease.

Cantaloupes and cucumbers have been successfully grown on the shallow Norfolk soils. These crops offer excellent opportunities to the special-crop farmer, owing to the abundance of land well adapted to them.

There are good opportunities for building up a profitable industry in the growing of early sweet potatoes for shipment. While a large crop of sweet potatoes is grown annually for home use, but little attention has been given to their production for outside markets. In view of the fact that potatoes can be put on the market as early as the middle of June, which is considerably earlier than can be done by those more northerly sections that have become famous for their sweet potatoes, there is no reason, unless it be exorbitant freight rates, why this industry should not prove a paying one. There is a large acreage of land well adapted to this crop. The deeper phases of the Norfolk sandy loam and fine sandy loam and the Tifton sandy loam are the best suited to the crop. A great number of varieties do well, but those locally known as "Spanish yams," "parrot yams," "yellow yams," and "red yams" seem to give most satisfaction and are of such quality as unquestionably would meet the requirements of any market.

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For an early crop the plants should be set in the field about the middle of March, on ridges from 8 to 10 inches high, and watered if the soil is not well supplied with moisture. An acreage application of from 500 to 1,000 pounds of an 8–2–10 fertilizer distributed in the drill and thoroughly mixed with the soil and listed on about three weeks before planting has proved very satisfactory on the Orangeburg and Norfolk fine sandy loams and sandy loams. Coarse barnyard manure, grain stubble, or some form of vegetable matter which when plowed under slightly opens up the soil so as to effect good aeration is advisable. The popular belief that new ground is best for sweet potatoes is accounted for in that the good results are largely due to the abundance of vegetable matter it contains. Well-rotted stable manure rich in nitrogen should be used sparingly, as such applications are apt to injure the crop, even to the extent of causing the potatoes to crack. Cultivation should be shallow, so as never to cut deeply into the bed, harrows and scrapers being good implements for this purpose. Cuttings from the early planted potatoes are used sometimes from the vines for a late crop, but slips from the bedded potatoes are used for the early crop.[a]

The Irish potato is another crop that can be grown for market. From 100 to 200 bushels can be grown upon an acre of the Orangeburg and Norfolk soils having a depth of at least 8 inches and not much more than 20 inches to the clay subsoil. Barnyard manure or cotton-seed meal used liberally in conjunction with 300 to 500 pounds an acre of a phosphate-potash mixture analyzing about 8–6 gives good results. A crop of rye turned under green is quite beneficial to the crop on the deep sandy soils. Very early spring potatoes can be grown without trouble, but the fall crop sometimes suffers from drought. Cabbage does especially well on the deeper phases of Norfolk fine sandy loam, on which type they have been successfully grown for early shipment. Heavy applications of stable or barnyard manure in conjunction with about 1,000 pounds of a 9–4–4 fertilizer give best results.

English peas, tomatoes, radishes, lettuce, spinach, turnips, snap beans, and onions can be grown very successfully, especially on the well-drained Norfolk fine sandy loam and sandy loam. The Tifton sandy loam and the "pimply" areas of both the Norfolk and Orangeburg soils produce extra early vegetables.

The natural conditions in Thomas County are favorable for the development of a great trucking industry, but owing to the long distances to large markets and the resulting high freight and express rates trucking has not attained any considerable degree of importance.

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[a] For further discussion of the sweet potato see Farmers' Bulletin 324.

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FRUIT AND NUTS.

Peaches do only fairly well. The fruit is inclined to rot and drop off. This may be accounted for, at least in part by the lack of care given the trees. There are many orchards of Le Conte, Kieffer, and Bartlett pears, and notwithstanding the fact that blight has checked the industry tremendously, some fairly good crops are made and sold at fair profits. Nothing is done to stop the spread of the disease. By pruning the affected branches and burning the badly diseased trees many orchards could be saved, at least for a much longer period than where carelessly left to the ravages of blight. The Kieffer is more resistant than other varieties. Plums, including Japanese varieties, can be grown successfully on most of the well-drained soils. Blackberries and dewberries grow in abundance and are rarely injured by disease or frost. The fig is preeminently suited to the soils and climate and grows profusely with little or no care. Strawberries can be grown quite successfully on the heavier phases of Norfolk and Orangeburg soils. The Scuppernong grape and a number of varieties suitable for marketing or wine do well, particularly on the well-drained Norfolk soils. There are several vineyards in the vicinity of Meigs.

Pecans do well, especially on the Norfolk fine sandy loam and the upland, well-drained hammock areas of both the Norfolk and Orangeburg soils. There is a pecan nursery near Thomasville, and many trees are being set throughout the county. Trees that have come into bearing give evidence of the probable success of the industry. The trees begin to bear at the age of 7 years. They should be set about 50 feet apart each way and cultivated carefully. Cowpeas can be grown between the trees to good advantage.

SUGAR CANE.

The growing of sugar cane for sirup is one of the most profitable industries of the county and its production is being increased rapidly. Large shipments are made from Ochlocknee, Pavo, and other points. On account of the wide areas of soil very well adapted to this crop the opportunities for development of the industry are almost unlimited. With the best of care and attention a very high-grade sirup is made. The deeper phases of the Norfolk fine sandy loam and sandy loam are the best for the crops. The sands and fine sands of both the Norfolk and Orangeburg series and the deep phases of the sandy loam and fine sandy loam of the Norfolk series produce a good grade of sirup, but require heavy applications of fertilizers, besides being so susceptible to drought as frequently to cause short crops. The Tifton sandy loam and the shallow phase of the Norfolk fine sandy loam and sandy loam and the Orangeburg sandy loam and

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fine sandy loam make heavy yields of sirup, but the quality is decidedly inferior, particularly in color, to that produced on the other soils named. It is believed that Portsmouth soils having a heavy subsoil within 10 to 15 inches of the surface would make a fair grade of sirup if thoroughly drained and well fertilized.

The cane is planted on ridges 3 to 5 feet apart and is cultivated in very much the same manner as corn, the essential difference being that with corn the object is to throw considerable dirt toward the stalks, whereas with cane the object is to keep the soil away from the stalks at first, or until a good stand of suckers is secured. Usually all fertilizers are applied in the drill and the whole cane stalks or 18-inch sections are laid in the drill, either in contact with the fertilizer or after it has been mixed with the soil, and then covered to a depth of 2 or 3 inches. Planting begins as early in the spring as the condition of the ground permits.

Any surface crusting offering resistance to the sprouting cane should be destroyed by a spike-toothed harrow. Cultivation begins early and is carried on for a much longer time than in the case of cotton or corn. After a good stand is secured, which is generally about the middle of June, soil is thrown about the stalks with sweeps so as to stop suckering or "stooling." After this, interridge cultivation is continued and the crop finally laid by from the first to the middle of July with four or five sweep furrows, which leaves the stalks upon a ridge. Sirup making generally begins about the last of October and continues until after Christmas. The leaves are stripped from the stalks before cutting and left in the field. Cane should be cut as soon after frost touches it as possible. The crop is always fertilized. Cotton seed, barnyard manure, compost, various grades of commercial fertilizers, and mixtures of kainit, phosphoric acid, and cotton-seed meal are used as manures. About a ton of commercial fertilizer per acre used in conjunction with 25 to 50 bushels of cotton seed and about 5 tons of well-rotted barnyard manure is considered a good application, although the average application is very much lighter than this. The lighter the soil the greater the requirement of fertilizer. Most of the farmers apply all of the fertilizers before seeding. Some, however, apply all the cotton seed, barnyard refuse, and compost used and one-half of the fertilizer in the drill at the time of seeding, the balance of the fertilizer being applied near the stalks about the first of June. The latter method seems to be the better one.

Experiments conducted with cane on the Norfolk fine sandy loam near Cairo indicate that for the medium phase of this type, and also for the deeper Norfolk sandy loam, an acreage application of 1,200 pounds of a 10–3–5 fertilizer applied before seeding and followed with two applications of 100 pounds each of sodium nitrate along-

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side the plants in June is a most effective method of fertilizing. For best results with the deep sandy soils the acreage application should be increased to from 1,500 to 2,000 pounds.[a]

Heavy applications of stable manure or well-rotted barnyard manure sometimes gives the sirup a dark color and an unpleasant salty taste. Sirup made on "cowpen land" is always of a poor quality. However, barnyard manure and compost are, when used in moderate amounts, very beneficial. Nitrogen should be more largely supplied by preceding cane with cowpeas or velvet beans, which crop leaves the soil in a most excellent mechanical condition. The sweet potato also is a good crop to precede cane. Corn and watermelons do better after cane than does cotton. Cane land should be plowed in the fall, turning the soil, in the case of the type having a shallow to medium surface soil, to a depth of 9 inches.

Stubble cane when burned over in the spring, "barred off," and harrowed across with a disk to loosen up the turf makes with the same fertilization and cultivation about the same yields as seeded cane. However, a great deal more sirup is made from the first crop than from the second one. The seed cane is placed in windrows and lightly covered with earth during the winter months. Cold, wet weather frequently damages the stalks, and it would seem that some better method could be devised for saving the seed crop.

The acreage yields of sirup run from 200 to about 600 gallons, according to soil, quantity of fertilizer used, and care in cultivation. An average of 400 gallons can be reasonably counted on, with fair treatment. Most of the crop in Thomas County is manufactured in open kettles by the farmer and sold in 33-gallon barrels.

TOBACCO.

As yet the cultivation of Sumatra wrapper tobacco has been tried in only one instance in Thomas County, but inasmuch as some of the soil types here are the same as those previously surveyed in neighboring Florida territory upon which the Sumatra wrapper tobacco industry is well developed, it is believed that it is only a matter of time before the industry will spread all over the section of the county where these soils are found. The discussion of the subject is intended for the guidance of those who may be contemplating the growing of this tobacco upon the Thomas County soils.

The medium deep phase of the Norfolk fine sandy loam is the grade of soil best suited to the production of the Sumatra type of wrapper

[a] It is fairly safe to conclude that there is little if any waste from an excessive application of potash and phosphate on plant canes, as the succeeding stubble crop will get the benefit; but an excessive application of ammonia will be lost, as it has practically all disappeared by the following year. Bul. No. 93, Bureau of Chemistry, U. S. Dept. of Agr., p. 30.

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tobacco. There are other grades of soil that will produce a leaf of good quality, such as the deep phase of the Norfolk fine sandy loam and the Norfolk fine sand, but such deep soils would require irrigation for best results. The Orangeburg fine sand is fairly well suited to the wrapper and even the fine sandy loam of this series produces a medium grade, though it is much better suited to the Cuban filler type of tobacco. The color and texture of the leaf as produced on the light-colored, medium deep Norfolk fine sandy loam in the neighboring Georgia and Florida tobacco territories comes nearest to meeting the demands of the tobacco trade, which requires a leaf of fine texture, small veins, even color, and a good finish.

The cultivation of tobacco should not be rushed into, but should be tried at first cautiously and only in a small way until the trade recognizes that a first-rate article can be grown. Farmers should be sure they have the proper soil for the production of a high-grade wrapper and should thoroughly understand every step of growing and curing the crop. In this connection Wilder says:

> For the average farmer there are several difficulties to contend with in growing this grade of leaf. The cost of erecting the shades and curing sheds is heavy, great care must be exercised in handling and curing the crop, small individual lots can not be assorted into the proper grades, and large areas require more capital than most farmers have. These conditions are sufficient to deter the average farmer from engaging in the business, but for the small grower the uncertainty of disposing of his crop for a satisfactory price, because he must take whatever is offered to him by controlling buyers, is even more serious. If the market were open to small growers, or if they could combine their crops in assorting and in sale, they might then, with large lots of a more uniform product, be able to dispose of their crop to better advantage. Of the success of the larger growers who are sure of a satisfactory market, there can be little question, and the industry offers excellent opportunities for extension on a large scale.[a]

The erection of slat shade, the kind most generally used, ranges from about $200 to $250 an acre. The posts for carrying the slat supporters are usually set 12 by 20 feet apart and stand 9 feet in the clear. The intervals between the slats should be so arranged that one-third to one-half of the ground will be shaded, and in order to insure an even distribution of shade on the plants the slats should be laid with their longest axis north and south. If well constructed, shade should last five years. A barn with a capacity for curing 2 acres of tobacco will cost about $250.[b]

Tobacco seed should be sown from February 15 to March 15, on a moist, sandy soil, or in a box bed kept damp by watering and shaded with cloth if practicable. The tobacco field should be broken flat in the fall to a depth of 10 to 14 inches, using a subsoiler when necessary

[a] Soil Survey of Leon County, Florida, pp. 29–30.

[b] For plans and specifications of tobacco barns, see Report No. 62, U. S. Dept. of Agr., pp. 25–29.

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so as not to turn up too much of the lower soil. About the first of March 20 tons (20 2-horse loads) of stable manure to the acre should be spread broadcast and plowed under to a depth of 6 inches, the furrows to be thrown at right angles to the first turning. Following this broadcast 400 pounds of slaked lime and harrow in thoroughly with a disk. About two weeks before transplanting a mixture consisting of 1 ton cotton-seed meal, 400 pounds steamed bonemeal, and 300 pounds carbonate of potash or 400 pounds sulphate of potash should be drilled in or applied broadcast and harrowed in. If the mixture is used in the drill, it should be thoroughly mixed with the soil with a shovel plow, listed on, and the bed broken open with a shovel plow, and listed back just before transplanting. Rows should be laid off 4 feet apart and the plants set from 10 to 14 inches apart in the row and watered. As it is desired to get a uniform growth and good stand the field should be gone over several times soon after transplanting to reset unhealthy or dead plants. The proper time for transplanting is between April 15 and May 20, although good crops have been made in adjoining territory when set late in June. Cultivation should begin five or six days after setting, and it should be at first deep and close to the plants with a straight plow, like a scooter. Subsequent cultivation should be shallow near the row and a little deeper in the center and should be done once a week or as often as necessary to keep the soil well mulched and as long as no injury is done the plants. Cultivation is sometimes carried on after harvesting begins. It is a common practice to plow one middle in the early part of the week and the alternate middle in the later part. It is especially necessary to plow as soon as possible after rains to destroy soil crusting, and any crust formed between the plants should be carefully broken with hoes. After the first hoeing a little dirt should be drawn around the stalks.

Various mixtures of Paris green are used to kill the bud worm and horn worm; these are also picked off by hand. The plant should be topped before the buds bloom. Following this topping suckers appear at the joint of each leaf and stalk, and these should be removed so as to direct the entire energy of the plant toward the development of the ripening leaves. On the stronger soils like the shallow Norfolk fine sandy loam and the Orangeburg fine sandy loam the top suckers are allowed to bloom so as to prevent too thick leaf development. A second crop, or sucker crop, is seldom gathered, and then only by some of the larger growers. Priming, as a rule, begins about sixty days after transplanting. The leaves are picked from the bottom a few at a time as they ripen and immediately carried to the barn, where they are strung 30 to 40 leaves to a stick and hung to cure. The curing takes more or less time, according to seasonal conditions, but the average period is about three weeks. In dry weather the barn is

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usually kept closed for two or three days, or until the tips of the leaves begin to turn yellow, then opened. The air should be changed in this way so as to keep the leaf in a pliable condition—neither too wet nor too dry. In case of damp weather fires are sometimes necessary to drive off excess moisture and prevent pole-sweat and stem-rot. When the midrib is dry the tobacco is cured so far as the farmer takes it. It should now be in "good case;" that is, in a moderately pliable condition, ready for the warehouse, where it is graded and subjected to the further process of bulk fermentation. Sun-grown Sumatra wrapper is fertilized and grown in about the same way as the shade-grown. The ordinary yields of the shade-grown product run from about 700 to 1,300 pounds.

Irrigation is coming into favor rapidly, and is commonly practiced where cheese-cloth shade is used. The influence of soil texture, especially upon the yield, is minimized under irrigation.

The Cuban seed-leaf cigar-filler tobacco does well on the Orangeburg fine sandy loam. This type is grown very much in the same manner as the Sumatra. A good fertilizer consists of an acreage application of 1,200 pounds of cotton-seed meal and 300 pounds of sulphate of potash. In growing this tobacco it should be rotated with other crops so as to include a green manuring crop.

SOILS.

The soils of Thomas County are predominantly sandy, there being a textural range in the surface material from light sand to moderately heavy fine sandy loam. A large proportion of the upland soils, though sandy in the surface portion, pass at a depth of from a few inches to something like 3 feet into either a bright-yellow or bright-red sandy clay, which in turn passes at a depth of from 3 to 4 or 5 feet into a compact sandy clay highly mottled with pinkish-red, drab, and yellow colors. The only clay exposures represent those areas from which the surface mantle of sandy material has been removed through erosional processes, as in case of the "gall spots" sometimes seen on slopes where the surface flow-off has been most rapid. The limit of coarseness in the original sandy material, which was laid down as marine sediments, is represented closely by medium sand, there being a marked absence of coarse quartz sand and gravel. The iron sandstone and claystone pebbles so abundant in the northern part of the area evidently have been formed in the soils during the processes of weathering that have taken place since the recession of marine water. These pebbles do not show a concentric structure, but simply represent sandy or clayey material which has been cemented solidly by iron oxides and hydrates. Occasionally the cemented material occurs in the shape of hardpanlike layers, but by far the

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greater part is found in more or less rounded fragments, varying from the size of small peas up to about 1 inch in diameter.

The materials giving rise to the several soil series of the area were originally laid down as off-shore deposits in the sea that formerly covered the entire region. These deposits were more or less assorted at the time of their deposition, the coarser sands being laid down near shore, while the finer sands, silt, and clay were carried in suspension and laid down in deeper water. Since the region was elevated and made dry land these depositions have been further modified by the processes of weathering, erosion, and other modifying agencies, and this has given rise to the various soil types and to the differences in the depth to clay. From small local areas on slopes the surface material has been carried off bodily, leaving the heavier clay of the subsoil exposed; or the finer particles have been washed out and transported to lower levels, leaving superficial layers of light material. In the flat uplands rain water, by carrying off considerable quantities of the fine soil particles, has also played an important part in the formation of these flat sandy soils, and this accounts in part for the deeper surface soils. However, there probably were differences in the depth of the sandy mantle at the time of emergence, as in many cases the soils apparently have not been altered to any considerable degree as regards texture and profile arrangement since that time. Some of the sandy ridges unquestionably represent original deep sand beds or beach lines.

Solution and chemical changes, particularly oxidation processes, have been active agents in weathering, especially in the matter of color changes. There has been a tendency for the better drained and better aerated subsoil material to assume red colors through oxidation of the iron compounds. The high oxidation of the iron compounds giving rise to the red color of the Orangeburg subsoils doubtless has resulted in part at least from the better drainage and aeration of the Orangeburg series. Both the Orangeburg and Norfolk soils may carry iron sandstone and claystone pebbles of exactly the same character, and which, in both series, probably have been formed in situ and under similar conditions. Frequently the Norfolk soils grade from flat upland locations almost imperceptibly into the Orangeburg soils, occupying slopes where drainage has been good. Such gradations do not suggest marked differences in the manner and time of the deposition of the soil material here. However, the fact that the soils of the Orangeburg series occupy quite extensive areas in the southern part of the county with but little associated Norfolk soils, the converse being true in the northern part of the county, would indicate that there were differences in the time of deposition as well as in time of emergence. The drainage of these Orangeburg soils in the southern part of the county is much better than that of the Nor-

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folk soils farther north, owing to the greater unevenness in the surface configuration and to the more mature drainage systems. The Orangeburg soils belong largely to the Lafayette of the Pliocene.

The Norfolk series is derived directly from the old Gulf floor, or what is usually referred to as the Coastal Plain deposits. The geological formation giving rise to the Norfolk of this region is described as the Columbia of the Pleistocene. The series in characterized by its rather even surface, which in places has only fair drainage. The surface soils are grayish in color and vary in depth from a few inches to 2 feet or more. The subsoils are uniformly yellowish.

The Portsmouth series is derived largely from the same materials as give rise to the Norfolk soils and owes its characteristics largely to the poor drainage conditions, which have favored the accumulation of dark-colored organic material and inhibited oxidation of the subsoil material.

The Susquehanna fine sandy loam probably represents more closely the character of the deep underlying materials of the area than do any of the other types, and probably belongs to a transition stage between the underlying limestones of the Eocene and the later formations which give rise to the Orangeburg and Norfolk soils.

The Chastain fine sandy loam is an alluvium type, confined to the broad stream bottoms. The lower plastic clay subsoil probably represents in part undisturbed sedimentary material.

The Meadow land along streams is quite variable, but is largely composed of sand and fine material washed down from the adjacent uplands. The upland areas of Meadow as found in depressions simply represent those poorly drained situations into which more or less fine material has been washed.

There are in the southern part of the county a few outcrops of limestone belonging to the Vicksburg-Jackson formation of the Eocene. A large part of the county is underlain by this limestone, but exposures are seen in but few places outside of stream slopes and "lime sinks." Sink holes represent depressions and openings into underground drainageways caused by the uneven dissolution of the underlying limestone formation. In a few unimportant spots the limestone has affected the character of the soil, giving rise in its decomposition to a greenish-yellow very plastic clay carrying considerable quantities of fragments of more resistant limestone or lime concretions.

Drainage conditions, texture, and soil depth are all factors that strongly influence soil productivity directly, while the organic-matter content and the condition of organic matter in soils largely determines structural conditions, and thus indirectly affect the productivity of soils very materially. Those soils that have good supplies of organic matter in favorable condition are less inclined to bake or

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crust, are easier to cultivate, and are very much more productive than the apparently lifeless, crusty, droughty soils low in organic matter.

According to the relative percentage of gravel and of the medium fine and very fine grades of sand, clay, and silt, as determined by mechanical analysis, the soils have been classified into sands, fine sands, fine sandy loams, sandy loams, and gravelly sandy loams. The types have been grouped into series—that is, those soils having similar characteristics of structure, drainage, color, topography, etc., have been grouped under a series name. The Orangeburg soils are characterized by their bright-red friable subsoil; the Norfolk by their bright-yellow friable subsoil; the Portsmouth by the poor drainage conditions, high content of dark-colored organic material, and drab or gray clammy subsoils; and the Susquehanna by the mottled, extremely plastic clay subsoil. The following classification shows the soils of the county grouped according to mode of origin and processes of weathering resulting in the important differentiations of the original marine sediments:

Description.	Soil.
Grayish soils with red subsoils derived from old (Lafayette) sediments under best drainage conditions.	Orangeburg sandy loam. Orangeburg fine sandy loam. Orangeburg fine sand.
Grayish soils with yellow subsoils derived from later (Columbia) sediments under moderately good drainage conditions.	Norfolk sand. Norfolk fine sand. Norfolk sandy loam. Norfolk fine sandy loam. Tifton sandy loam.
Dark-colored soils with light-colored subsoils formed from Lafayette and Columbia materials under poor drainage or semiswampy conditions and intermittent wet and dry stages.	Portsmouth sandy loam. Portsmouth fine sandy loam. Portsmouth fine sand.
Grayish soils with mottled plastic subsoils derived from the exposures of the underlying older sedimentary material representing the deep substratum.	Susquehanna fine sandy loam.
Alluvium.	Chastain fine sandy loam.
Unclassified alluvium and poorly drained upland depressions.	Meadow.
Unclassified alluvium, extremely poorly drained.	Swamp.

The local names of soils have been brought out in their proper relationship to the several types under the type descriptions. These local names in some instances do not correspond texturally with the class names as governed by analytic determinations of the percentages of the various sizes of soil particles. For instance, a sandy loam with the clay near the surface occasionally will be called "clay land." It is generally the custom in sections of predominantly light soils to speak of those soils as clays or loams which in a region of predominantly heavy soils would be called "sandy loams" or "clay loams."

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Where soil boundaries have not been drawn with absolute accuracy, owing to the impracticability of determining the exact limits in some cases, and where small bodies of soil do not conform closely with the type in which they have been mapped, but have been included on account of the impossibility of showing such small areas on a map of the scale used (1 inch to the mile), careful consideration of the type description will eliminate the possibility of confusion on the part of one using the soil map. In some instances where a small area embraces considerable diversity in soils it was necessary to represent the general average of the area on the map, but with the soil descriptions carefully in mind little trouble will be had with such nonconforming areas.

The following table gives the names and areas of the several soil types shown on the accompanying map:

Areas of different soils.

Soils.	Acres.	Per cent.	Soils.	Acres.	Per cent
Norfolk fine sandy loam	110,016	31.8	Norfolk sand	5,504	1.6
Orangeburg fine sandy loam	53,760	15.5	Portsmouth fine sand	3,968	1.2
Norfolk sandy loam	49,216	14.2	Swamp	3,328	1.0
Meadow	29,120	8.4	Norfolk fine sand	3,264	.9
Orangeburg fine sand	28,032	8.2	Orangeburg sandy loam	1,344	.4
Chastain fine sandy loam	20,928	6.1	Susquehanna fine sandy loam	832	.2
Portsmouth fine sandy loam	13,888	4.0	Total	345,728	.....
Portsmouth sandy loam	12,928	3.7			
Tifton sandy loam	9,600	2.8			

TIFTON SANDY LOAM.

The surface soil of the Tifton sandy loam is a yellowish-gray to dark-gray moderately heavy sandy loam, from 5 to 15 inches deep, averaging about 10 inches. The subsoil is a bright-yellow moderately friable sandy clay to a depth of about 28 inches, below which it frequently passes into a compact though friable yellow clay mottled slightly with reddish colors, and slightly heavier than the overlying portion. A characteristic feature of the type is the presence of 10 to 25 per cent of small iron sandstone and claystone pebbles disseminated through the soil mass. These pebbles have the appearance of concretions and consist of a sandy and clayey material that apparently has been cemented through the precipitation and oxidation of iron salts carried into the soil mass in solution. Their interior color usually is dark red, but occasionally a small pebble is yellow throughout, in which case the pebble has a rather rotten or soft structure, indicating that the iron has not been thoroughly oxidized, or has assumed the form of hydrates through decomposition processes. These pebbles are most abundant in the surface soil on the crest of ridges and in the higher locations where erosion has removed

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a portion of the finer material, and for the same reason the soil depth is shallowest in such locations. Usually the depth of soil increases and the content of pebbles diminishes with descent to lower levels, until the type passes into another soil, generally the Orangeburg or Norfolk sandy loam.

While the presence of large sand grains gives the soil quite a sandy feel, there is sufficient interstitial fine material to make the texture quite favorable with respect to the maintenance of moisture. The texture and structure of the subsoil also are such as favor the maintenance of supplies of moisture favorable to crops. Heavy rains cause the soil to run together and later it bakes and forms at the surface a crust, which is easily destroyed by shallow cultivation. Small hummocks of the heavy yellow clay subsoil are seen here and there, marking those places where trees have been blown down and turned up the underlying material on their roots. There are a few areas of considerable extent which approach quite closely the texture of a loam. The Tifton sandy loam is called "hard pimply land."

The timber growth consists of longleaf pine. Wire grass is abundant everywhere except in cultivated fields. In its surface configuration the type is generally undulating or flat, with gentle slopes toward the streams. Occasional sink holes and "black gum ponds" are seen. The surface drainage is excellent.

The greater part of this type of soil occurs in a large body in the northwestern part of the county in the neighborhood of Meigs. It is interrupted here usually by the Norfolk sandy loam and by lower wet land along the streams. There are several small isolated areas in the northern and southeastern parts of the county. Some of the lesser areas are too small to be shown on the map.

The Tifton sandy loam is the best cotton soil in the area, producing with fair treatment from one-half bale to 1 bale an acre. Cotton suffers but little from drought or rust. Long-staple cotton does better on this than on any other soil of the area, frequently yielding as much as the short staple. It is grown less extensively, however, on account of the greater care required in its production. Yields of from 15 to 20 barrels of sirup can be made, but the quality is not generally so good as that produced on the lighter Norfolk soils, being considerably darker in color. Corn does fairly well, but sometimes suffers from drought.

Good yields of oats and excellent crops of peanuts are made. This is not a typical vegetable soil, but cantaloupes, watermelons, cucumbers, onions, Irish potatoes, string beans, and strawberries find it well suited to their requirements. The soil is a little heavy in some places for the best results for sweet potatoes, but the well-drained areas make good yields. Velvet beans and cowpeas make heavy growths and improve the structure and general condition of the soil.

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One of these should be grown in rotation with other crops regularly. Cowpeas sometimes fail to fruit in abnormally wet years and such failures have discouraged the less aggressive farmers in the cultivation of this crop. Rye, oats, and vetch could be produced to advantage as spring forage crops.

The ordinary grades of commercial fertilizers, together with considerable quantities of cotton seed, are used for cotton, corn, and cane. Some farmers apply 500 pounds or more for cotton, expecting with such an application 1 bale to the acre, but the usual application ranges from 300 to 500 pounds. Little nitrogen should be bought in the commercial form for cotton, oats, or corn, but should be secured by growing leguminous crops and by carefully saving barnyard manure. By growing a crop of velvet beans, or cowpeas with corn, then a crop of sugar cane or fall-sown oats and a crop of cotton the third year with an application of 400 or 500 pounds of a 10–2–5 fertilizer, an average yield of 1 bale to the acre should be made. The yields of the other crops grown in such a three-year rotation would all average much higher than at present and at the same time the expenses for fertilizer would be moderate. Cotton-seed meal, or the rotted seed, are decidedly beneficial to sugar cane, but less of this material would be required for this crop grown in the above rotation, although the usual application of potash and phosphoric acid would not be materially changed.

The following table shows the average results of mechanical analyses of fine-earth samples of the soil and subsoil of this type:

Mechanical analyses of Tifton sandy loam.

No.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per ct.	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
18570, 18582, 18584	Soil	4.6	14.2	9.9	35.1	15.6	8.5	11.6
18571, 18583, 18585	Subsoil	2.6	10.0	8.7	27.8	12.7	10.2	28.3
18572	Lower subsoil	1.2	6.9	9.3	22.4	8.3	10.5	41.0

NORFOLK SAND.

The soil of the Norfolk sand to an average depth of about 6 inches is usually a dark-gray sand or a gray sand slightly darkened with organic matter. It is underlain to a depth of 36 inches or more by a yellowish-gray to pale yellow sand, which becomes coarser and looser in the lower portion. This sand material may extend to a depth of 10 feet or more near streams, but gradually becomes shallower as the distance from the stream increases. The material consists largely of subangular quartz grains, and whenever it is cultivated without frequent incorporation of vegetable matter it becomes lighter colored and more incoherent. When wet the virgin soil is moderately com-

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pact. The type supports a growth of longleaf pine interspersed with scrub oak. This scrub oak grows more abundantly where the soil is a little coarser textured than usual and where the underlying clay is at a great depth. There is a scant sod of wire-grass on most of the uncleared land.

The Norfolk sand occurs as narrow strips bordering the bottom lands of the Big and Little Ocklocknee rivers and their tributaries. In some places there is a gradual rise directly from the bottom land to the general upland level. The topography of most of this land is flat or billowy, with usually a slight slope away from the margin of the bottom land. There are several small, rounded knolls and narrow ridges in the uplands.

The Norfolk sand owes its origin to an alteration of the original sedimentary material common to the area by which the finer soil particles were worked out to leave the sand matrix. The process of alteration consisted either of a translocation of the fine particles by erosion, a slight reworking of the original material by stream action when the water stood at a higher level, or the combined action of these agencies. The topography of these sand deposits in places is somewhat terracelike in appearance, but is not what would be classed as true stream terrace; in fact the topography in many places is not very unlike that of the heavier members of the Norfolk series occurring along the stream. The soil has not the appearance of true alluvium, although it is possible some of it was deposited by stream water during an earlier geological stage.

The type is an open, well-drained, warm-natured soil which is only moderately productive. All crops are apt to suffer for lack of moisture. Cultivated areas are used principally for the general farm crops—cotton, corn, and cane—the yields of which are even lower than on the Norfolk fine sand. Owing to its good drainage and thorough aeration it is best adapted to early truck. Sweet potatoes, English peas, beans, cantaloupes, watermelons, and strawberries would do well with liberal applications of fertilizer. The organic matter or humus content, which in no little degree determines the productivity, is exhausted so rapidly that all crops should be grown in rotation with cowpeas or velvet beans. These are crops that grow readily and afford a comparatively inexpensive means of supplying the much-needed vegetable matter and nitrogen. One or the other of these legumes should be turned under while partly green every two or three years. An acreage application of about 25 to 40 bushels of burned lime at the time of turning under the vines would assist in decomposing the material, in neutralizing any acid effect, and in binding and firming the soil particles. Liberal applications of barnyard manure are beneficial. Phosphoric acid and potash should be supplied in the percentage ratio of about 2 to 1 and at the rate of from

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500 to 1,500 pounds an acre for sweet potatoes, melons, cane, and vegetables. Cotton-seed meal is quite beneficial to Irish potatoes and sugar cane. It is said that heavy applications of commercial fertilizers cause "firing" or shedding of the bolls in the case of cotton; but it is believed the danger would be largely diminished by using such fertilizers in conjunction with liberal applications of vegetable manure, either barnyard or green manure or the vegetable refuse left by crops of cowpeas or velvet beans. A mixture analyzing 10–2–8 applied at the rate of 300 to 400 pounds to the acre has given very good results with cotton grown on this grade of soil.

From 80 to 175 bushels of sweet potatoes, 60 to 150 bushels early Irish potatoes, and from 200 to 300 gallons of sirup of a very superior quality can be secured with judicious management. Under the prevailing treatment yields of from one-sixth to one-fourth bale of cotton and from 5 to 15 bushels of corn are considered good. Cotton, corn, and oats should not be grown extensively, as the soil unquestionably is an early-truck type. Of the general farm crops, it is best adapted to cane and potatoes. Wrapper tobacco has been grown on this soil in Grady and Decatur counties by using large quantities of fertilizers and irrigating. The leaf produced has a very fine texture. Cultivation should be quite shallow and frequent in order to conserve moisture. Fall plowing is unnecessary, except for the purpose of turning under vegetation.

The following table shows the texture of the soil and subsoil of the Norfolk sand:

Mechanical analyses of Norfolk sand.

No.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18564	Soil	2.2	21.5	20.2	38.3	8.8	5.9	3.2
18565	Subsoil	3.1	25.9	16.4	36.1	11.7	4.5	2.3

NORFOLK SANDY LOAM.

The Norfolk sandy loam consists of a medium heavy grayish to dark-gray sandy loam from 8 to 16 inches deep, underlain by a yellow clayey sand which quickly passes into a mealy, friable, bright-yellow sandy clay. Generally at a depth of from 40 to 60 inches there is a substratum of mottled yellow, reddish, and drab compact sandy clay which usually persists to great depths. Usually the surface soil changes to pale yellow at about 5 inches. Often the soil portion carries from 10 to 20 per cent of small iron gravel (iron sandstone and claystone), in which case the type is locally termed "pimply land," This gravelly material does not in itself affect the value of the land;

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but usually its presence is an indication of a subsoil comparatively near the surface. The nearer the sandy clay comes to the surface the stronger the land, for as a rule the soil in such areas is loamier and better suited to the maintenance of favorable supplies of moisture. In some of these shallow "pimply" areas the type resembles quite closely the Tifton sandy loam, the important difference being the lighter average texture of the Norfolk sandy loam. Not infrequently the soil is gravelly, while the subsoil is practically free from gravel. Again, the subsoil may have these pebbles interspersed throughout its mass, or they may occur at various depths in strata of several inches thickness so compact as to approximate the condition of hardpan. Such land as this last is locally spoken of as having a rock bottom.

Sometimes the soil extends to a depth of 26 or more inches, in which case the crop adaptation and productiveness is noticeably different from the shallow phase. In this deep phase the soil is a light sandy loam and the subsoil either a clayey sand or distinctly a sandy clay. There is a gradual increase in the depth of the soil as the Norfolk sand is approached; a gradual transition is particularly noticeable with the descent of slope. The deep phase, however, sometimes occurs at numerous places in the uplands where it is not associated with the Norfolk sand. The extent of this deep phase is quite large, but individual areas are comparatively small. There is in some places a transitional phase between the Norfolk sandy loam and the Norfolk fine sandy loam, in which the medium and fine grades of sand predominate, to the exclusion of the coarser grains common to the true type. This is quite noticeable in the section to the south and southwest of Pavo and east of Boston, in fact, all along the southern border of the general belt of the coarser soils in the northern part of the county. On the other hand, there are some few areas that approach in texture quite closely to Norfolk coarse sandy loam, as is seen in the body just southwest of Coolidge and along the county line between Pavo and Barwick.

Along the stream slopes where the drainage has been particularly good the color of the subsoil is redder, and the material is heavier and more clayey than is usual for the type. In places it is decidedly plastic and quite similar to that of the Susquehanna fine sandy loam. Such nonconformities, when extensive enough to be outlined on the map, were separated and mapped as that type. The native timber growth consists almost entirely of longleaf pine, there being here and there only small clusters of shortleaf or slash pine, and occasionally a sprinkling of dogwood, oak, and hickory. In the flat and poorly drained areas gallberry bushes are found. Wire grass flourishes throughout the pine forests. Most of the merchantable timber has been cut.

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The Norfolk sandy loam is confined largely to a belt in the northern part of the country lying north of a line drawn through Ochlocknee toward Merrillville and thence to Oaklawn on the eastern county line. There are several areas outside of this general belt, as those to the east and southeast of Boston.

The topographic features of the type include many broad and sometimes rather indistinct interstream ridges with long, gentle slopes, and many well-defined ridges between lesser streams, low hills, and broad, flat, upland stretches. In some sections, as those to the west of and between the Ocklocknee rivers, the surface configuration is that of an undulatory to rolling country of smooth contours, with here and there an amphitheaterlike escarpment near the head of a stream. In the northeastern part of the county there are broad, flat and nearly flat stretches which slope almost imperceptibly toward and merge with the poorly drained members of the Portsmouth soils. The drainage here is often inadequate, owing to the absence of a well-established drainage system. There are within such flat areas, and also in the gently undulating phases of the type, many small depressions and sink holes which hold water throughout a good part of the year and support growths of either black gum, cypress, or mayhaw. The greater part of the type has excellent surface and underdrainage. Very little complaint of droughtiness is heard from farmers on the shallow phases, but crops frequently are injured in dry weather where the surface soil is deeper than 15 or 20 inches.

The natural productivity of the Norfolk sandy loam is quite variable, depending, as does its crop adaptation, upon the depth to the subsoil. The type as a whole is a good cotton soil, but the shallow phase makes better yields and the effect of manures is more lasting. Where the surface soil is deeper than 15 or 20 inches cotton is inclined to go too much to weed in seasons of heavy rainfall. The shallow phase is better suited to peanuts and oats, while the deep phase makes better average yields of corn, watermelons, and sweet potatoes, and a brighter colored sirup. The type as a whole is well suited to forage crops, particularly cowpeas, velvet beans, and sorghum. Cucumbers, beans, tomatoes, and Irish potatoes do well. The chief crops grown are corn, cotton, cane, peanuts, watermelons, and sweet potatoes. The acreage yields usually range from one-third to one-half bale of cotton, 10 to 20 bushels of corn, 300 to 450 gallons of sirup, 100 to 300 bushels of sweet potatoes, and about one-half a car of watermelons. Heavy yields of sirup are made on the "hard pimply" areas, but the quality is not generally as good as that from the lighter phase. Oats are generally put in after Christmas on rough, poorly prepared land, and the yields rarely go higher than 15 to 20 bushels an acre. This crop should be seeded in the fall on thoroughly prepared land, or else cultivated by the open-furrow system.

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In view of the fact that the Norfolk sandy loam is susceptible to rapid improvement by having its organic-matter content built up through the medium of cowpeas and velvet beans grown in regular rotation with other crops, the average yields of all crops should be markedly increased without any considerable extra effort. Cotton, on the shallow phase, in rotation with corn, oats, sweet potatoes, and the legumes, and properly fertilized should average upward of three-fourths of a bale to the acre, while 35 bushels of corn, 30 bushels of oats, and 300 to 350 bushels of potatoes should be secured in years of normal seasons. This is one of the best sweet potato soils of the area. Long-staple cotton does very well on the shallow phase, especially the "pimply" areas. Strawberries, English peas, and pears can be grown quite successfully.

Commercial fertilizers, mostly of the ordinary grades (analyzing approximately 8–2–2), are generally used for cotton at the rate of from 250 to 400 pounds per acre; for corn, at the rate of 150 to 250 pounds; for watermelons, 300 to 600 pounds; and for sugar cane, 500 pounds or more. The best mixture, according to practical experience of many good farmers, for cotton should analyze 10–2–3 for the shallow phase and 10–3–5 for the deep phase. Barnyard manure is very beneficial for all crops.

Commercial fertilizers should be used always in conjunction with some form of vegetable manure, either barnyard or green manure or the refuse of crops of cowpeas and velvet beans, as the effect is more lasting and more favorable. Cotton seed and cotton-seed meal are beneficial, particularly for cotton, corn, and sugar cane. Sweet potatoes do not require much organic matter, especially barnyard manure. They do well with applications of 500 to 1,000 pounds of 10–2–5 fertilizer per acre, following oats, corn, sugar cane, or cotton. Nitrogen should always be reduced to the lowest possible point in commercial fertilizers by being supplied through the growing of leguminous crops.

The soil should be fall broken in case of the shallow phase to a depth of from 6 to 10 inches. The deep phase would not be materially benefited by fall plowing, except to turn down a covering of vegetation. Cultivation should be shallow and frequent. However, this frequent cultivation is less necessary, perhaps, than in case of the Norfolk fine sandy loam, for the reason that the Norfolk sandy loam is not so inclined to crust.

It is believed that the medium-textured grades of the type, that is, those areas carrying only a small proportion of coarse sand, would produce a fair grade of Sumatra wrapper tobacco.

The Norfolk sandy loam can be bought for about $7 to $15 an acre, where there is not a heavy growth of merchantable timber.

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The following analyses of soil and subsoil show the composition of the Norfolk sandy loam:

Mechanical analyses of Norfolk sandy loam.

No.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18578	Soil	6.2	20.6	10.5	32.7	14.7	7.2	7.7
18579	Subsoil	4.5	12.8	8.2	23.6	11.3	8.6	31.4

NORFOLK FINE SAND.

There are two important phases of the Norfolk fine sand: The soil of the "scrub oak" phase consists of a loose gray fine sand of a soft feel, ranging in depth from about 8 to 20 inches. The subsoil, to a depth of 3 feet or more, is a light-gray to pale-yellow fine sand of a distinctly velvety feel. The timber growth is mainly longleaf pine interspersed with scrub oak. Such land is locally called "white sand" or "scrub oak sandy land." It occurs in comparatively small areas, largely as narrow strips along stream slopes, and in the uplands as ridges or hillocks.

A second phase, known as "sandy hammock" and "river hammock," consists of 5 to 10 inches of a grayish-brown or dark-gray slightly loamy fine sand overlying a pale-yellow fine sand. Both soil and subsoil of this phase are rather more compact than in case of the "scrub oak" phase. The soil is found in rather flat areas along the Ocklocknee River and along the slopes of smaller streams. That along the river is generally flat, and the subsoil is usually not encountered nearer the surface than 10 or 15 feet. In the case of that found along the slopes of smaller streams a friable, compact fine sandy clay mottled pinkish red, drab, and yellow is usually encountered at from 3 to 5 feet.

The hammock phase of the Norfolk fine sand supports a growth of magnolia, bay, beech, hickory, white and post oak, ironwood, maple, and some shortleaf pine. The loamy structure of the surface soil is due largely to the accumulation of leaf mold.

The Norfolk fine sand is confined largely to the west-central part of the county, where it occurs in small, widely separated areas. The type is usually well drained and very little of it is subject to overflow.

Those areas along the Ocklocknee River probably owe their origin in a measure to the work of the river in its earlier stage of development, while those along slopes of the smaller streams represent both material left upon the removal of clay and silt by erosion from an original heavier soil and that which has accumulated as wash material. In some of the higher lying positions the type seems to have been but little altered since its emergence.

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The scrub-oak phase of the Norfolk fine sand is considered rather an undesirable agricultural soil for the reason that it is necessary to make frequent and heavy applications of fertilizer in order to produce anything like fair crops. Owing to its open nature and its low organic-matter content it is rather droughty. Manurial applications are not as lasting on account of the rapid decomposition of organic matter induced by thorough aeration and also on account of the ease with which fertilizers are carried downward out of reach of the plant roots. This soil, however, can be built up and kept in fair condition by turning under at frequent intervals crops of velvet beans and cowpeas in conjunction with applications of barnyard manure and fertilizers. The incorporation of vegetable matter brings about a desired loaminess of structure which makes the soil very much more resistant to drought and much more productive.

The Norfolk fine sand is naturally a warm soil, well adapted to the production of early vegetables like Irish potatoes, watermelons, cantaloupes, cucumbers, lettuce, English peas, radishes, etc. Velvet beans, sorghum, and cowpeas can also be grown successfully. Sugar cane does well when heavily fertilized. With an acreage application of from 1,500 to 2,000 pounds of an 8–3–4 fertilizer, from 250 to 400 gallons of a light-colored sirup of excellent flavor can be produced. From 100 to 200 bushels of extra early sweet potatoes of good shipping quality can be grown with an acreage application of 1,000 pounds of an 8–4–4 fertilizer. The type is much better suited to corn than to cotton, the latter going too much to weed in wet years. Cultivation should be more nearly flat than with the heavier soils. Fall plowing is necessary only for the purpose of turning under vegetable matter. Vegetation should be turned under to a depth of 6 to 8 inches. Frequent shallow cultivation is absolutely necessary in dry seasons in order to conserve moisture. Watermelons and sugar cane are particularly apt to suffer from drought.

This type is a special-purpose soil and should not be used for general farming. Its most attractive possibilities appear to be in the production of the early vegetables enumerated above. The hammock phase is naturally the more productive, at least for a period of several years following clearing. Good crops of corn, sugar cane, peanuts, and potatoes and fair crops of oats can be secured with smaller applications of manure than in the case of the scrub-oak phase. This sandy hammock land always holds moisture exceptionally well for so light a type. These damp locations near streams, where the organic content is higher, are admirably suited to growing tobacco plants for resetting. A fine grade of Sumatra wrapper tobacco may be grown on this phase, especially with irrigation. Under cultivation the differences in the two phases gradually disappear and after 4 or 5 years the crop yields are about the same on the one as on the other.

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The following table gives the results of mechanical analyses of typical samples of the soil and subsoil of this type:

Mechanical analyses of Norfolk fine sand.

No.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18566	Soil	1.1	2.6	2.5	68.4	11.8	8.8	4.8
18567	Subsoil	.0	1.9	3.2	66.7	18.1	4.3	5.7

NORFOLK FINE SANDY LOAM.

The Norfolk fine sandy loam of Thomas County was divided and mapped in three phases—shallow, medium, and deep. The constituent materials of these phases are the same, and the separations were warranted mainly on the basis of differences in crop values, as determined by the depth of the surface soil.

Shallow phase.—The soil of the Norfolk fine sandy loam, shallow phase, to a depth of 5 to 10 inches consists of a light to a moderately heavy fine sandy loam. The color, usually a dark gray in the surface soil, changes to a lighter tinge a few inches below. Where the dark-colored organic matter has been more or less exhausted or the top soil mixed by cultivation, with the lighter colored material beneath or with the yellow subsoil, the color varies from dull gray to pale yellow. On the other hand, where the native vegetative growth and undergrowth is heavy the color may be a very dark gray or nearly black, this being especially true in the poorer drained situations. The subsoil, to a depth of 18 or 20 inches, is a yellow fine sandy clay and below this a bright-yellow fine sandy clay. Where the drainage is poor, the subsoil sometimes is slightly mottled with reddish or drab in the lower portion. It is usually quite friable when moderately dry but is noticeably plastic when wet. Quite frequently both soil and subsoil carry small iron pebbles in quantities ranging from 10 to 20 per cent of the soil mass. These pebbles occur either disseminated throughout the soil mass or in strata anywhere in the profile, being sometimes conspicuous in the surface soil and absent below, or the reverse. The deep substratum, as frequently exposed in road cuts, presents a variegated mottling of yellow, drab, and pinkish red and is a compact clay somewhat coarser grained than the overlying soil.

The type is sometimes called "clay land," "hard land," or where gravelly, "pimply," or "hard pimply land." It is confined largely to the western part of the county north of Pine Creek, occurring most extensively in the vicinity of Thomasville and Ochlocknee. It is conspicuously absent from the southern, southeastern, and northeastern parts of the county and the country lying between the Big

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and Little Ocklocknee rivers. The greater proportion occurs as flat or undulating interstream country like that to the south of Ochlocknee. Where the streams are more abundant and have cut comparatively deep valleys, as in the sections to the south and north of Thomasville, the topography is more rolling, and the type is more frequently encountered on the slopes where a more pronounced erosion has removed a part of the top soil. On the slopes and in the more rolling country the drainage is quite good, and at the same time a supply of moisture very favorable to crops is maintained throughout the year, even in dry seasons. Surface drainage is so poor in case of the flat stretches that the soil becomes saturated in wet weather and soon gets into a soggy condition. This feature could be remedied easily by digging drainage outlets to the branches, which can be reached within short distances nearly everywhere. These branches near their heads often amount to mere wet places, but they mark the natural drainageways, which can be opened and extended without any great outlay of money.

The soil is inclined to run together during heavy rains, so that subsequent sunshiny weather frequently causes an undesirable baking or surface crusting, necessitating immediate shallow cultivation to restore favorable tilth and to prevent excessive surface evaporation of moisture. Such crusting is perhaps more common with this type than with any other in the area. This tendency can be reduced to a minimum by keeping the soil well supplied with organic matter, as by turning under barnyard manure, cowpeas, or coarse litter of any description.

The native timber growth consists mainly of longleaf pine. There are "hammocky" spots which support a growth of oak, dogwood, and hickory, and often a scattering of dogwood is seen in the pine timber. There occur here and there small sinks or basins, rarely of more than 1 acre, which hold water most of the year. Thick clusters of black gum and mayhaw grow in these. The well-drained areas, as with all the types, support a sod of wire-grass throughout the pine timber, while a scattering growth of gallberry bushes is generally seen in the poorly drained areas.

The shallow phase of the Norfolk fine sandy loam is one of the best cotton, oats, peanut, and forage crop soils of the county. Corn does not do quite so well as on the deeper phases, and, also, crops like watermelons, sweet potatoes, cantaloupes, cucumbers, and tobacco prefer a deeper top soil. Sugar cane gives a heavy yield of sirup—300 to 500 gallons to the acre—but the quality is inferior to that produced on the Norfolk soils having a greater depth to the clay. With proper treatment cotton should yield from one-half bale to 1 bale, oats from 20 to 40 bushels, corn 10 to 30 bushels or more. The type has considerable merit as a medium late truck soil for such

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crops as strawberries, Irish potatoes, tomatoes, beans, and onions. Cabbage does well only when the drainage is thorough, and at the same time when a readily available supply of moisture is maintained. A crop should never be grown in flat locations, except where the drainage conditions have been so perfected as to insure against the occurrence of soggy conditions. Pecans and pears do well where the drainage is good. Crimson clover, Bermuda grass, cowpeas, velvet beans, beggarweed, crab-grass, and sorghum find this soil well suited to their requirements. With deep plowing so as to turn up and thoroughly mix with the surface soil a small portion of the subsoil, coupled with fall seeding following either cowpeas, velvet beans, or crimson clover, oats could be grown quite successfully.

Commercial fertilizers should be used in conjunction with organic manures as much as possible. The legumes should be depended upon largely for nitrogen and should be grown in rotation with the various crops at least as often as once every two or three years. Following a leguminous crop there should be very little nitrogen in the fertilizer to be used. In accordance with practical experience the best fertilizer for this soil should analyze about 10–2–4 for cotton, oats, and vegetables.

In view of the marked adaptation to peanuts, cowpeas, velvet beans, and sorghum, more hogs and stock could be raised and marketed at a profit. Fall plowing to a depth of 6 to 11 inches is advised for all crops. Considering that the type is especially benefited by deep plowing and thorough preparation, stumps should be more generally removed, so as to fit the land to the use of disk plows, drills, and harrows. Oats should be drilled in for best results. The ridge cultivation in vogue is well suited to this type of soil.

The Norfolk fine sandy loam, shallow phase, can be bought at from $8 to $15 where there is not a considerable growth of merchantable timber.

Medium phase.—The soil of the Norfolk fine sandy loam, medium phase, consists of a light to medium heavy fine sandy loam 10 to 20 inches deep. Under virgin timber the color varies from dark gray in the surface 5 or 6 inches through light gray to very pale yellow in the lower portion, while that which has been under cultivation for several years is usually dull gray in the surface portion. The content of silt averages considerably less than in the shallow phase of the Norfolk fine sandy loam. The subsoil passes from a yellow fine sandy clay into a heavier bright yellow fine sandy clay at about 26 inches, and finally, at from 4 to about 10 feet, into a compact mottled sandy clay substratum. For the most part, when normally dry, the subsoil possesses a mealy, friable texture, although in the poorer drained situations it may be fairly plastic, while on the lower slopes it not infrequently is reddish yellow in color and quite plastic. As a rule the sub-

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soil possesses that texture and structure favorable to the maintenance of a supply of moisture almost exactly meeting the requirements of crops growing under normal conditions of weather and cultivation. The soil is less inclined to run together during rains than its shallower correlative, on account of its lighter texture. However, though to a lesser degree, slight crusts do form, which require light cultivation as early as possible after rains. In the vicinity of Aucilla and Linton Lake, in the southeastern part of the county, the soil is noticeably heavier, approaching a light fine loam in texture, while the subsoil is a very friable, mealy yellow fine sandy clay, somewhat heavier than the average of the medium phase. Here the subsoil frequently becomes reddish yellow at about 3 feet. The soil in this locality is more apt to assume a compact, hard structure in dry weather. A scattering growth of hardwood is quite common in the pine forests. In some locations, particularly in the vicinity of Patton and Boston, this phase of the Norfolk fine sand loam grades into the Norfolk sandy loam so gradually as to make it rather difficult to draw the boundary between the two.

Small red iron pebbles are quite common, occurring in the surface soil or anywhere throughout the soil mass. A considerable area of the type carries enough iron-sandstone and claystone pebbles to give the soil a decided gravelly nature. Some of these more pronouncedly "pimply" or gravelly spots have been indicated on the map by symbols. There are gall spots here and there on slopes and knolls, indicating those places where the surface soil has been washed off, leaving the clay subsoil exposed. On the lower slopes the phase generally passes into the deeper Norfolk fine sandy loam. The timber growth is about the same as that of the shallow phase of the Norfolk fine sandy loam, consisting in the main of longleaf pine, with here and there a scattering of dogwood and occasionally a "hammock" area. On the slopes near streams magnolia, bay, maple, beech, and shortleaf pine are common.

The Norfolk fine sandy loam, medium phase, occurs throughout the greater part of the area outside of the country south of Pine Creek, northwest of Ochlocknee, the forks of the Ocklocknee rivers, and the northeastern part of the county above a line drawn through Coolidge, Patton, and Oaklawn.

Its surface configuration is quite variable and includes many broad, gentle slopes, nearly flat to gently rolling interstream country, and crests of imperfectly developed ridges. It is more generally rolling and better drained than the shallow phase. The natural drainage is such that ditches are very seldom needed, and cultivation is easy over a wider range of moisture conditions.

The soil is susceptible of much improvement by growing and turning under leguminous crops, either after the crop has matured or in

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the green stage. Such a practice would greatly benefit succeeding crops. Preparation of the land should be done in the fall, plowing preferably to a depth of 6 to 10 inches.

This is one of the most desirable soils of the area. It is adapted to a wider range of crops than most of the types and probably is the surest soil in the county to produce good average yields. Under the prevailing system of soil management cotton produces about one-third bale, corn from 8 to 20 bushels, sirup of excellent quality 250 to 450 gallons, oats 15 to 20 bushels, and sweet potatoes from 100 to 200 or more bushels an acre. The pebbly areas are considered best for cotton and earliest for watermelons. The loamy phase, like that in the southeastern part of the county, produces the best average crops of corn. All the crops grown in the county do at least fairly well. Those that seem best adapted to this soil are corn, peanuts, cane, watermelons, cabbage, cantaloupes, cucumbers, beans, English peas, sweet potatoes, Irish potatoes, rye, and tobacco.

The medium phase of the Norfolk fine sandy loam is the best wrapper-tobacco soil in the county, or in this general region of southern Georgia and contiguous Florida, being identical with that on which the better yields and grades are secured in Florida and in Decatur and Grady counties, Georgia. From 1,000 pounds to 1,400 pounds of shade-grown and from 500 to 1,000 pounds of sun-grown wrapper can be produced.

Cabbage of the early varieties, for example, the Wakefield, does well. Excellent yields of this crop were grown for shipment near Thomasville this year. Heavy applications of stable manure and about 1,000 pounds of a 9–4–4 fertilizer per acre were used.

Fertilizers for cotton and corn, according to best results secured, should analyze about 10–2–5. Applications of from 500 to 1,500 pounds of commercial fertilizer are used for sugar cane, 500 pounds for watermelons, 150 to 250 pounds for corn, and 200 to 500 pounds for cotton. Sweet potatoes of the Spanish yam variety, fertilized with an 8–2–10 grade, at the rate of 1,000 pounds to the acre, should yield upward of 300 bushels.

Deep phase.—The surface soil of the Norfolk fine sandy loam, deep phase, is quite similar in texture, color, and general appearance to that of the medium phase of the type, differing essentially in the greater depth to the subsoil, in structure, which is more open, and in a slightly lighter average texture. In a typical section the soil consists of a dark-gray or gray loamy fine sand to very light fine sandy loam which at a depth of about 10 inches overlies light-gray to pale-yellow material of about the same texture. The color of the surface soil depends largely upon the drainage conditions and the organic matter content. In the virgin forests and poorer-drained

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areas and fields, where the supply of vegetable matter has not been allowed to run low, the color is a dark gray. Where the organic matter has accumulated under good conditions of drainage, or has been pretty thoroughly depleted, the color is a decided gray.

The fine sandy material overlies the true subsoil anywhere between 20 and 36 inches, averaging about 2 feet. The subsoil consists of a yellow fine sandy loam, generally becoming heavier with depth, and quickly passing into a bright-yellow clay loam or sandy loam, which sometimes is very silty. Where the depth to this heavier subsoil material is as much as 36 inches the soil has been mapped as Norfolk fine sand. Iron pebbles occur here and there on the surface and throughout the soil mass just as with the shallow and the medium phases.

The timber growth is mainly longleaf pine. There is considerable shortleaf pine and hardwood on the stream slopes. Locally the type is termed "sandy land." It is closely associated with its shallower correlatives occurring in the same general belt. While in its surface configuration it presents the same variety in topography, this phase is more generally found on the lower slopes and on knoll-like hills. As a slope soil it owes its origin, in part at least, to accumulation of sandy material washed from higher levels. Away from streams it has been formed by a washing out of the finer particles from the superficial material.

Natural drainage is so good that crops frequently suffer from drought. In general the soil needs vegetable matter to increase its loaminess and retentiveness of moisture.

The deep phase of the Norfolk fine sandy loam is not as strong a soil as the shallow and medium phases of the type, but on the other hand it makes heavier yields than does the more droughty Norfolk fine sand. It is especially adapted to sugar cane, watermelon, sweet and Irish potatoes, and corn. The varieties of cotton grown are inclined to produce heavy growth of stalk with but little fruit, particularly in wet years. The crop also suffers considerably from rust. The average yield of sirup is not as high as on the heavier soils, but the quality is superior. Heavy applications of fertilizer are needed to bring the yields up to as much as 400 gallons an acre. From 1,500 to 2,000 pounds of high-grade fertilizer, in conjunction with liberal applications of cotton-seed meal or barnyard manure, is not considered too much for a good crop. Barnyard manure is less apt to cause deterioration in qualities of the sirup than on the heavier soils. A yield of one-half car of watermelons per acre can be secured with an application of from 500 to 800 pounds of a 10–3–4 fertilizer, used in conjunction with cotton-seed meal or barnyard manure. Sweet potatoes run from 150 to 300 bushels. Cotton yields from one-fifth to one-

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third bale under the prevailing methods of soil treatment, while corn runs from 10 to 25 bushels. The yield of oats is relatively low. Cabbage, tomatoes, and English peas can be successfully grown with heavy applications of fertilizer and barnyard manure. The soil is a little too light for best results with peanuts and onions. Fairly good crops of crab grass are secured from watermelon fields.

The organic-matter content should be increased by plowing under green or half-matured crops of grass, cowpeas, and other legumes. Cowpeas and velvet beans should be grown in rotation with all crops. Fall plowing is not needed, except to turn under a covering of vegetable matter. Fertilizers for cotton should run high in phosphoric acid and potash and low in nitrogen. Five hundred pounds of a 10–2–8 brand per acre has been found a very effective application.

The following table gives the results of mechanical analyses of the several phases of Norfolk fine sandy loam:

Mechanical analyses of Norfolk fine sandy loam.

No.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
Shallow phase:		*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
18058	Soil	0.0	2.5	3.4	48.9	23.6	17.6	4.8
18059	Subsoil	.3	1.7	3.2	42.7	17.7	18.9	16.3
18060	Lower subsoil	.4	2.3	3.2	45.6	9.8	18.5	21.1
Medium phase:								
18589	Soil	.1	4.7	7.3	48.3	17.8	9.2	12.6
18590	Subsoil	.1	3.0	6.3	34.6	13.3	5.8	37.1
Deep phase:								
18045, 18047	Soil	.3	3.1	2.3	55.1	23.9	10.0	4.6
18046, 18048	Subsoil	.3	2.7	1.8	48.0	19.2	7.8	19.5
18049	Lower subsoil	.3	3.1	3.3	40.1	23.9	9.0	20.2

ORANGEBURG SANDY LOAM.

The Orangeburg sandy loam is a dull-gray to grayish-brown medium sandy loam, underlain at from 10 to 15 inches by a red friable sandy clay. It is generally rolling and well drained, usually occupying the slopes of streams. There are only a few small isolated areas in the county. It is confined largely to the general belt of the coarser soils in the northern part of the county.

The type is adapted to about the same crops as the Orangeburg fine sandy loam, from which soil it differs only in being coarser in texture and a little less productive.

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The following analyses of soil and subsoil show the composition of this type:

Mechanical analyses of Orangeburg sandy loam.

No.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18593	Soil	4.3	31.2	7.6	30.6	17.3	4.7	3.9
18594	Subsoil	3.8	28.7	6.4	16.8	8.1	4.1	32.2

ORANGEBURG FINE SAND.

The Orangeburg fine sand is a gray to grayish-brown fine sand, underlain at from 15 to about 28 inches by a reddish fine sandy loam, which quickly passes into a friable red fine sandy clay. A substratum of compact fine sandy clay mottled pinkish red, yellow, and drab is generally encountered at from 4 to 5 feet. Occasionally on steep slopes the surface soil has been washed off, leaving the clay subsoil exposed. Such "gall spots" are generally too small to be shown in the map. As a rule the depth of the surface soil increases with descent of slope, the depth to the clay not infrequently being 3 feet or more on the lower slopes and in the valleys or in the interridge flats. The timber growth is mainly longleaf pine. Wire grass is abundant everywhere in the timber.

The topography of the type for the most part is rolling. In the southern part of the county it has been cut up considerably by erosion. The stream valleys are deep and broad and there are a number of hills or eminences from which good views of the surrounding country can be had. The slopes, however, are mostly gentle and washing is not serious. Sidehill ditches or terraces which follow the contours of the slopes are invaluable in the prevention and checking of erosion. Toward the northern part of the county the type gradually gives way to members of the Norfolk series and its surface configuration becomes less uneven. The natural drainage is good. Crops sometimes suffer from drought where the depth to clay is more than 20 inches.

The most extensive areas are those in the southern part of the county in the section drained by Pine, Wards, and Connell creeks and between Thomasville and Boston in the sections drained by Olive and Aucilla creeks. A considerable portion of the Orangeburg fine sand is under cultivation. Cotton is the principal crop, and generally enough corn is grown for home use. The average yields are lower than they should be, largely for the reason that much of the land is worked by careless tenants. When the soil is well supplied with organic matter, as can be readily done by growing cowpeas or velvet beans in rotation with cotton, corn, oats, or other crops, yields of from

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one-half to three-fourths bale of cotton, 25 to 40 bushels of corn, and 20 to 40 bushels of oats per acre can be secured. The usual yields, however, are lower than these figures. Cotton seems to go less to stalk in wet seasons than on the Norfolk fine sand; still there is considerable trouble on account of this tendency of the plant. The crop suffers from rust occasionally and needs more potash than is generally applied. The experience of some of the most successful farmers on this soil indicates that a complete fertilizer carrying approximately 8 per cent phosphoric acid, 2 per cent nitrogen, and 6 to 10 per cent potash, applied at the rate of from 300 to 500 pounds an acre is a most excellent application, particularly when made in conjunction with barnyard manure, or a green manuring crop, as, for instance, cowpeas. Sorghum and sugar cane do well, and a good quality of sirup is made. Vegetables, like beans, Irish potatoes, watermelons, cantaloupes, and cucumbers, can be successfully grown. The type produces a good grade of cigar-wrapper tobacco when the depth to the clay is 20 inches or more.

Land of this type of soil can be bought for $5 to $10 an acre.

The following table shows the results of mechanical analyses of typical samples of the Orangeburg fine sand:

Mechanical analyses of Orangeburg fine sand.

No.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18596	Soil	0.1	1.5	2.7	65.5	18.8	6.1	5.5
18597	Subsoil	.0	.9	1.7	52.6	12.1	5.3	27.7

ORANGEBURG FINE SANDY LOAM.

The surface soil of the Orangeburg fine sandy loam consists of a brown, reddish-brown, or dull-gray fine sandy loam, ranging from a few inches to 15 inches in depth. The brown and reddish-brown colors in the soil usually give way to lighter colors with increase in depth to clay, and the texture also becomes somewhat lighter where the subsoil lies at a greater distance from the surface. The subsoil is a friable red fine sandy clay to a depth of 36 inches or more, below which is usually found a mottled compact friable sandy clay, similar to that underlying the Orangeburg fine sand and the better drained Norfolk soils. Along the steep stream slopes the subsoil sometimes becomes quite plastic and the type here occasionally grades into the Susquehanna fine sandy loam. Both soil and subsoil hold moisture well and under normal conditions the subsoil usually has about the same degree of friableness as that of the Norfolk fine sandy loam, but when wet it is a little more sticky and plastic.

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Small iron concretions or pebbles occur in local areas, most commonly on the crests of ridges and knolls, where erosion has been active and the surface soil is shallow. These pebbles may be found interspersed evenly throughout the soil and subsoil, or they may occur most abundantly in sections of the soil mass at various depths. The pebbly or "pimply" areas are considered most productive. The depth to the subsoil usually increases on the lower slopes, owing to removal of the soil from higher to lower positions by wash. In some of the small valley-like locations between knolls and hills, the soil depth is sometimes greater than 15 inches, and the subsoil instead of being red is more nearly yellow in color. The type is locally styled "red clay" or "red land" according to the color of the soil and depth to clay.

This soil is more inclined to wash than any other type in the area, owing to the fact that the subsoil takes up water rather slowly. During the heavy rainfalls the soil soon becomes supersaturated and has a tendency to flow and wash away. This accounts for the "gall" or "clay spots" here and there on the steeper slopes. On the whole such eroded areas are scarce and the total acreage of land damaged in this way is small. The tendency to wash can be reduced to a minimum by increasing the water-holding capacity of the soil and subsoil by means of deep plowing and the incorporation of organic matter by turning under manure, cowpeas, or other crops. Much can also be done to check erosion by constructing sidehill ditches and by terracing.

The Orangeburg fine sandy loam occurs most extensively in the southern half of the county. Its surface is generally the most rolling of any soil type in the area, excepting perhaps the Orangeburg fine sand. Much of it occurs on the steeper stream slopes. It is also sometimes encountered in small areas in nearly flat bodies on the uplands and often on the crests of ridges and hills. Sink holes are fairly abundant.

On account of the rolling character of the surface the natural drainage is good. Crops suffer very little from drought; in fact, rather more injury comes from an overabundance of moisture in wet seasons, when cotton frequently produces an immense stalk with but little fruit.

The timber growth is mainly longleaf pine. There are hammock areas, both in the uplands and along slopes, which support heavy growths of dogwood and oak, with a scattering of hickory. Here the soil is generally shallow and more loamy than usual. Clumps of mayhaw, black gum, and cypress are frequently seen in the sink holes and swampy depressions, while in the better drained pine woods there is always a good growth of wire grass.

The Orangeburg fine sandy loam is a productive, durable soil. It is best adapted to cotton, oats, and forage crops. Corn does only

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moderately well. Heavy yields of sirup can be made, but the quality is inferior both in color and flavor to that produced on the Norfolk soils. The acreage yield of cotton runs from about one-half to 1 bale, of corn from 8 to 15 or 20 bushels, and of oats from 15 to 30 bushels. Rather poor average yields of oats are secured, for the reason that the crop is too often sown in late winter or spring on roughly prepared land, whereas it should be sown in the fall or early winter on a well-plowed and thoroughly harrowed seed bed.

Judging the experiences of good farmers, the best commercial fertilizer for cotton, corn, and oats should analyze about 10–2–5. Fertilizer applications for cotton should be somewhat lighter upon this type than upon the Norfolk soils, the usual rate being from 300 to 400 pounds to the acre, according to the depth of soil and the organic matter content, lighter applications being necessary on the shallow "pimply" phase. For corn and oats, 250 to 350 pounds is sufficient. Barnyard manure is the best fertilizer that can be used on this soil, although cowpeas and velvet beans help wonderfully, whether cut for hay, grazed, or plowed under. These crops should be grown in rotation with the other general farm crops and occasionally on the deep phase a crop of cowpeas should be plowed under while in the half-matured stage. Commercial fertilizers should always be used in conjunction with some form of organic matter. Deep fall plowing should be practiced generally.

The Orangeburg fine sandy loam is not considered a good wrapper-tobacco soil. The leaf is inclined to be thick and coarse textured, and the burn is often poor, but it is the best filler-tobacco soil in the country. It should produce from 500 to 1,000 pounds or more per acre of the Cuban filler type. Crimson clover would do well on this soil. Alfalfa probably would succeed on the heavy or hammocky areas. Irish potatoes do well where the soil is from 10 to 15 inches deep. The type is not so generally suited to vegetables as are the Norfolk soils. Peanuts, sorghum, and vetch can be grown successfully. Cowpeas for hay would prove a profitable crop. Vetch as a winter cover-crop would protect slopes from washing and at the same time improve the soil and furnish an excellent early spring forage or grazing crop.

The following table shows the results of mechanical analyses of this type:

Mechanical analyses of Orangeburg fine sandy loam.

No.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18591	Soil	0.6	5.9	9.8	50.0	16.7	7.5	9.3
18592	Subsoil	.3	4.0	6.4	41.6	11.4	8.5	27.4

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PORTSMOUTH SANDY LOAM.

The soil of the Portsmouth sandy loam is a dark-gray to nearly black medium sandy loam, carrying a high percentage of organic matter and averaging about 15 inches in depth. The subsoil is a gray or drab sandy loam, frequently mottled with reddish and yellow colors. It is always quite compact and usually saturated with water below 24 inches. Sometimes the soil is a sand to a depth of 3 feet or more, in which case the lower material is exceedingly compact and wet. The type represents areas in which the drainage has been so imperfect as to favor the accumulation of organic matter.

The Portsmouth sandy loam occurs largely in the northeastern part of the county, occupying gentle undulating and flat upland country, stream slopes, and slight depressions. The timber growth is largely longleaf pine, and in the poorer-drained locations it usually supports a thick growth of gallberry bushes, and frequently "bugles" and palmettoes. The type is sometimes spoken of as "mud-land," and is generally considered poor, and but little is under cultivation. When drained, good cotton can be grown where there is a sandy loam subsoil within 10 to 20 inches of the surface, and upon such areas good sugar cane, rice, corn, and strawberries could also be produced. By means of open ditches drainage may be established with little difficulty, except upon those areas which have a quicksand subsoil. The quicksand caves in and causes much trouble with the ditches. Such areas, however, are easily determined by the fact that they support a growth of "bugles" or palmettoes.

The following analyses of soil and subsoil show the composition of the Portsmouth sandy loam:

Mechanical analyses of Portsmouth sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18556	Soil	1.0	17.1	11.5	33.6	23.4	6.4	1.9
18557	Subsoil	1.5	14.9	10.9	33.5	18.6	5.3	15.0

PORTSMOUTH FINE SANDY LOAM.

The Portsmouth fine sandy loam occurs as flat upland, as upland depressions, and as areas along the slopes and around the heads of streams. The soil varies from a dark-gray to nearly black loamy fine sand to a fine sandy loam, and generally passes at from 10 to 15 inches into a light-gray fine sand. At about 20 to 25 inches this light material grades into a gray or drab heavy fine sandy loam to clay loam, mottled with yellowish and reddish colors. The lower subsoil is almost always saturated. Frequently in the flat areas the

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material included between 10 to 20 inches has a dark-brown, iron-stained appearance, which has been caused by the precipitation of iron hydrates from the leachings of the surface soil. In many places the light-gray fine sand persists to a depth of 3 feet or more, but such bodies represent areas that were too small to warrant separation. In the depressions fine material has washed in from the surrounding higher land, giving the soil here a more loamy texture than is typical.

The Portsmouth fine sandy loam consists of the same soil material that constitutes the Norfolk fine sandy loam, except that there is more clay in the subsoil of the latter. The difference between these types has been brought about largely by the poor drainage conditions that have obtained in the Portsmouth fine sandy loam, conditions that have favored the accumulation of dark-colored vegetable matter in the soil portion and that have hindered oxidation of the subsoil by exclusion of air.

The timber growth consists mainly of longleaf pine. There is, however, considerable "slash" pine along the slopes of streams and in depressions. A dense undergrowth of gallberry bushes is everywhere present, and in places where the soil is underlain by "quicksand" or saturated material palmetto and pitcher plants (locally called "bugles") are common. The bugle land and palmetto flats are considered as being extremely poor. The line of separation between this soil and the better drained Norfolk and Orangeburg soils can be pretty accurately determined by a careful observation of the vegetal growth. There is much less wire grass and always a heavier growth of gallberry on this type than on the well-drained soils. The stream slope phase often follows up gentle slopes nearly to the general upland level, and occasionally extends out into the uplands as broad stretches of "piney woods" or "gallberry flats," as in the case of the large area on Lost Creek. There are some level areas lying next to and at a slight elevation above the bottom land along the rivers and some of the larger streams, such as the body west of the Ocklocknee River on the Atlantic Coast Line Railroad. Although these areas at first sight have the appearance of second bottoms, they probably are not true second terraces, inasmuch as similar flat areas are common in the uplands at considerable distances from streams. On the steeper slopes the type is generally found next to the stream meadow land as narrow strips. Many areas occur as slight depressions around the heads of streams, occasionally in deep amphitheaterlike excavations, representing probably old sink holes which have had their sides eroded away.

The type is found largely throughout that part of the county lying north of the main line of the Atlantic Coast Line Railroad. It is

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much less conspicuous south of this line and in the Meigs and Ella Belle districts. In the northern part of the county it is closely associated with the Portsmouth sandy loam, where it occurs as flat and gently undulating areas of longleaf-pine land. There are a great many small bodies of the type, mainly depressions and wet-weather ponds, throughout the county which were too small to show on the map. The more swampy of these are known as "black gum," "cypress," or "mayhaw" ponds, according to the timber growth.

The Portsmouth fine sandy loam is generally considered an unproductive soil, and for this reason only a small portion has ever been put under cultivation. It is believed, however, that the main bodies of the type could be drained readily by means of deep open ditches and put into a fairly productive condition. The chief trouble would come from caving and filling in of the sandy subsoil. Some of the narrow slope strips have a substratum of impervious clay, which would make drainage rather difficult, if not ineffective. At present, however, the question of drainage is not pressingly important because of the extensive areas of uncleared, well-drained lands that are available for cultivation.

This soil thoroughly drained would produce good corn, strawberries, onions, and probably sugar cane and celery. Some good crops of rice have been grown without ditching. A few areas that were brought under cultivation by ditching have, after several years' cultivation, become somewhat lighter in color as a result of the better areation and organic matter decomposition.

The following table gives the average results of mechanical analyses of samples of the soil and subsoil of the Portsmouth fine sandy loam:

Mechanical analyses of Portsmouth fine sandy loam.

No.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per ct.*
18558, 18561	Soil	0.4	3.0	4.1	60.6	23.2	6.6	2.5
18559, 18562	Subsoil	.1	2.5	3.5	63.8	19.8	5.9	4.9
18560, 18563	Lower subsoil	.2	2.3	3.5	58.1	21.9	6.4	7.6

PORTSMOUTH FINE SAND.

Only a small extent of the Portsmouth fine sand was mapped in Thomas County. The soil, to a depth of about 8 inches, is a black fine sand of high organic matter content. This is underlain at about 8 inches by either a gray or an iron-stained fine sand, which, at about 2 feet, passes into a compact gray or drab fine sand, usually saturated with water. This lower saturated portion caves and flows in exca-

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vations in such a way as to make drainage of the type rather a serious problem. The largest area lies 2 miles east of Thomasville. Several areas had to be included with the Portsmouth fine sandy loam because of their small size and intricate association with this type.

The type is of little agricultural value. Rice, probably, could be grown with a fair degree of success, and corn and sugar cane probably would do fairly well with the establishment of good drainage.

The following table gives the results of mechanical analyses of this soil:

Mechanical analyses of Portsmouth fine sand.

No.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18554	Soil	0.9	6.3	6.0	62.8	13.7	7.2	2.3
18555	Subsoil	.7	4.9	5.3	58.9	21.4	6.7	1.4

SUSQUEHANNA FINE SANDY LOAM.

The Susquehanna fine sandy loam is a dark-gray fine sandy loam, underlain at a depth of from 6 to 20 inches by mottled pinkish-red and drab stiff impervious clay or by a yellow clay slightly mottled with red and drab. This subsoil material when wet is extremely plastic and adhesive and when dry becomes very hard. The mottled clay sometimes passes into a greenish-yellow or a white material free from grit which resembles fuller's earth. A piece of this impalpable material will stand for days in running water without showing signs of disintegration. In marginal strips along stream slopes the depth of soil is quite variable, increasing with the descent of slope, accordingly as material has accumulated from above by wash. Limestone fragments are sometimes seen in the subsoil, and there are some small strips along the steeper slopes where limestone comes quite near the surface. Here the subsoil color is usually a greenish yellow and it would seem that such areas have been at least partially derived from limestone. There are several small flat upland areas, like the one south of Ochlocknee.

The Susquehanna fine sandy loam is usually referred to as "pipe clay." Small upland areas where the subsoil is quite near the surface are sometimes called "cowhide land." The type is quite limited in extent. A number of areas were too small to be shown on the map. Practically none is under cultivation. The timber growth is mainly longleaf pine.

Cotton, peanuts, and forage crops would do fairly well. Sweet potatoes, vegetables, tobacco, and fruits would not succeed.

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The following table shows the results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Susquehanna fine sandy loam.

No.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18598	Soil	0.7	2.9	1.2	26.7	43.7	14.5	10.1
18599	Subsoil	.0	.6	.2	7.7	16.2	10.4	64.1

CHASTAIN FINE SANDY LOAM.

The Chastain fine sandy loam comprises the more open, broad river and stream bottoms, which are fairly uniform in soil texture.

The bottom lands or "river flats" of the Ocklocknee River consist for the most part of grayish and dark-gray fine sandy loam to fine sand, underlain usually at from 2 to 4 or 5 feet by an impervious stiff fine sandy clay mottled drab, yellow, and red. This clay sometimes comes very near the surface, especially near the line of contact with the upland soils in which situations the soil is more soggy than where there is greater depth to the clayey material. In case of the typical or loamy phase the soil ordinarily is a light fine sandy loam, dark-gray at the surface and gray or drab below, while the subsoil is a yellow drab, or a mottled yellow and drab, clammy fine sandy loam to fine sandy clay. The lighter phase, occurring mainly as small erratic mounds, consist of a grayish fine sand, underlain by a drab or light-gray material of the same texture.

The surface of the Chastain fine sandy loam is quite flat except for occasional interruptions by sloughs, old stream channels, and small depressions, some of which contain water the year around. In some of the old stream channels and small depressions the soil is usually dark colored and mucky. The bottom lands of the Ocklocknee River vary in width from a quarter to three-quarters of a mile, and are so subject to overflow that none of the type is at present under cultivation.

The Chastain fine sandy loam is popularly considered very poor land. Much of the type could be improved by ditching and made to produce grass and forage crops; but with the large extent of available upland it is not likely that any attempt will be made to bring this soil under cultivation in the near future. At present it is covered with longleaf pine, which is valuable for the production of lumber and turpentine. Scattering gallberry bushes and palmettoes are common.

A considerable total area of the Chastain fine sandy loam is found along such streams as Aucilla, Big, Coon, Pine, Piscola and Wards

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creeks, and here the impervious clay substratum is not so near the surface, and the soil proper is a uniform light fine sandy loam.

It is believed that with ditching much of this type, in particular that found in the southern part of the area along Wards, Pine, Aucilla, and Connell creeks, where overflows are less common and a considerable extent is not subject to overflow at all, could be brought into condition for growing good crops of corn.

MEADOW.

Broadly speaking, Meadow includes land which is too wet for cultivation, yet not so poorly drained as to be covered with water. For convenience and more specific treatment the type will be discussed under three heads or phases: Meadow of the poorly drained small stream bottoms; the quasi-bottom lands, and the Meadow found in upland depressions.

Adjoining nearly every small stream in the area are narrow strips of poorly drained, soggy bottom land of variable texture which receive much seepage water from adjacent slopes and rarely dry out to a good firm condition. They usually begin around the heads of streams, even of those which run only in wet seasons, and follow along as marginal strips to the more open bottom land of the larger streams. Such land, though quite variable in texture, is generally dark-colored and mucky in the upper portion and quite sandy below. Nearly white sand is found to a depth of 3 feet or more in places. Occasionally a stiff whitish or bluish-drab clay occurs at a depth of 3 feet, sometimes in the shape of lenses, the interstitial material being sandy. Again the soil may be a heavy loam or a silt loam. The timber growth consists mainly of magnolia, bay, maple, poplar, beech, longleaf and shortleaf pine. There is always a dense undergrowth of gallberry and other water-loving shrubbery. These wet bottom lands are popularly considered as worthless for agricultural purposes, and practically none is under cultivation. Corn would do well in many places, were the land thoroughly ditched and drained.

Another grade of Meadow, or quasi-bottom land, is found in the southern part of the county, where in some of the broad valleys and in the lower situations good soil has been brought down from the slope and deposited along the small streams and sloughlike waterways. Some of these waterways are merely sloughs, the water soaking in the ground or running only in protracted wet seasons and during heavy rainfalls. Such land is quite diverse in composition, but when ditched thoroughly produces good corn and oats. Live oak and pine constitute the common timber growth on this grade of Meadow.

Still another class of Meadow is found in the shallow sink-hole depressions which contain water during a part of the year. Such land

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embraces those shallow ponds that are usually dry in summer. Some of these depressions hold water the year around and are called "mayhaw," 'cypress," or "black gum" ponds, according to the growth. Many of the areas were too small to be shown on the map. Certain areas could be drained and utilized for the production of rice.

Not much of the Meadow type will be put under cultivation until the country is much more thickly settled and the well-drained uplands more generally utilized.

SWAMP.

The areas mapped as Swamp embrace the excessively wet stream bottoms, as for example such as are found bordering the lower courses of Aucilla and Pine creeks.

The soil is a dark-colored material with a wide range of texture and is more or less commingled with decaying vegetation. These Swamp areas gradually blend with the somewhat better drained meadow land. Along the eastern end of Lake Linton in the southeastern part of the county is a body of Swamp about 1 square mile in extent which consists of a marshlike flat nearly always covered with water. This phase of swamp known as "prairie land" supports a luxuriant growth of water-loving grasses (mainly reeds) very valuable for pasturage.

SUMMARY.

Thomas County, situated in southwest Georgia, on the Florida line, has an extent of 345,728 acres or about 540 square miles. The topography varies from flat to gently rolling. There are broad stretches of interstream country in which the drainage systems are so immature that considerable bodies of land are too wet for agriculture in their natural state. The Big and Little Ocklocknee rivers and the larger creeks like the Aucilla, Pine, Wards, Big Piscola have broad bottoms which are in whole or in part subject to annual overflow. These streams have cut comparatively deep valleys.

The summers are long and hot, though not as hot as would be expected in this latitude on account of moderating breezes from the Gulf. The mean temperature of the three hottest months, June, July, and August, is 81° F.; the mean temperature for the coldest months, December, January, and February, being 53° F. Snow seldom falls, but heavy frosts may be expected at any time from the middle of November to the first of March.

Transportation facilities are very good for the larger part of the county. Railroads radiate in 6 directions from Thomasville. The dirt roads are straight and are kept in remarkably good condition throughout the year.

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It also lies in the best part of the sugar-cane sirup region. A large quantity of sirup is made, and the industry is gradually being extended upon a profitable basis.

Cotton, both the long and short staple varieties, is produced throughout the area. Corn, oats, velvet beans, cowpeas, sorghum, and other forage crops, sweet potatoes, and peanuts (for hogs) are grown extensively throughout the area. Watermelons are an important specialty.

Pears, figs, grapes, and plums do well on the better drained soils. There are unlimited opportunities for the development of the trucking industry.

There is a considerable acreage of land which will produce good yields of the very best quality of the Sumatra wrapper type of tobacco. There is also an extensive area of land highly adapted to the Cuban filler tobacco.

More barn manure should be produced and larger quantities of "compost" used. Home mixing of fertilizers is profitable. Both cotton-seed meal and cotton seed are excellent fertilizing materials.

Too little attention is paid to rotation. The same crop should not be grown continuously on the same land, but the crop should be changed from year to year.

The soils of Thomas County vary from moderately heavy fine sandy loam to gravelly or "pimply" sandy loam. Besides the miscellaneous soils there are representatives of three important series—the Norfolk, Orangeburg, and Portsmouth series.

The Norfolk fine sandy loam has been divided into three phases, according to variation in depth to the yellow clayey subsoil. The shallow phase (with a soil depth of a few inches to 10 inches) is well suited to cotton, oats, forage crops, and peanuts, but is a little too heavy for best results with corn, tobacco, sugar cane, watermelons, potatoes, and truck generally; the medium deep phase (10 to 20 inches to the subsoil) is the best sugar cane and Sumatra wrapper tobacco soil of the region and produces good corn, potatoes, forage crops of all kinds, vegetables, and fair cotton. Pecans, pears, plums, and grapes do well. The deep phase (20 to 30 inches to the subsoil) produces very fair corn, an excellent quality of sugar-cane sirup, and various vegetables, but is too droughty for tobacco without irrigation. Cotton is inclined to go too much to weed in wet seasons. All crops require extra heavy applications of fertilizer and manure on this last phase.

The Norfolk fine sand is very similar in its crop adaptations to the deep phase of the Norfolk fine sandy loam, but is more droughty and requires heavier manurial applications. It is an excellent vegetable, but a poor cotton soil.

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The Norfolk sandy loam produces good crops of all kinds of vegetables, forage crops, and such fruits as are adapted to the climate. Cotton does very well when the depth of the surface soil is not over 15 inches, as do also peanuts and oats. Sugar cane, corn, and sweet potatoes require a soil depth of from 10 to 20 inches for best results. Strawberries, though not extensively grown, would do well on the shallow phase of this soil. The type is not quite as productive as the Norfolk fine sandy loam. The fruit crops adapted to this latitude do well on this type.

The Norfolk sand is a loose, droughty soil which requires large manurial applications, particularly of organic manures, for profitable returns. Green crops should be plowed under in the half-matured stage occasionally. It is a warm-natured soil well suited to extra early truck.

The Tifton sandy loam is the best cotton soil of the area. It makes heavy yields of sirup, but the quality is somewhat inferior. Oats, corn, and forage crops do well. The type is generally not so well suited to truck crops as the lighter soils. It produces extra early vegetables. Cotton, with fair treatment, produces a bale to the acre. The long staple finds its requirements more nearly met than on other soils except some of the shallow "pimply" phases of the Norfolk sandy loam and fine sandy loam, which give about the same results.

The Orangeburg fine sandy loam is admirably adapted to the production of the Cuban filler type of tobacco. It also produces excellent crops of cotton, oats, and forage crops. Corn does fairly well, as do also peanuts, sweet potatoes, Irish potatoes, and watermelons. Good yields of sirup are made, but sometimes the color is quite dark, especially where the subsoil comes near the surface. Vegetables generally are only moderately successful. Pecans, pears, and plums do well.

The Orangeburg fine sand produces good corn, forage, and truck crops, as in case of the other deep sandy soils. Cotton is apt to weed out badly in wet seasons and rust in dry seasons. Sweet potatoes, Irish potatoes, and watermelons do well. Sumatra wrapper tobacco does fairly well on this soil, where the underlying clay is not nearer the surface than 22 inches.

The Orangeburg sandy loam is suited to about the same crops as the Orangeburg fine sandy loam, the essential difference between the types being that the latter is a little more productive and requires lighter manurial applications.

The Portsmouth soils, on account of their poor drainage conditions, are not cultivated except to a very small extent. When the sand persists to greater depths than 15 or 20 inches the type is rather unproductive even when well drained. It is believed that rice, cotton, and

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sugar cane would do fairly well on the fine sandy loam. Very little use can be made of the Portsmouth soils without extensive ditching.

The Susquehanna fine sandy loam is an unimportant type and owing to its unfavorable topographic position and poor subsoil aeration quite unproductive. Very little is under cultivation.

The Meadow is predominantly sandy and unproductive on account of poor drainage conditions. None of this type is under cultivation, but a considerable proportion could be brought into fair condition of productiveness by artificial drainage.

The methods of cultivation in general are suited to the soils and conditions, especially in the production of sugar cane, cotton, melons, and peanuts. Some improvement, however, might well be made in the culture of corn, potatoes, and vegetables. The preparation of land for oats generally is too meager. The heavier soil should be plowed deeper and earlier. The well-drained soils that have been under cultivation for any considerable time are generally in need of organic matter, such as can be supplied to best advantage by growing cowpeas, velvet beans, vetch, etc., to be grazed, mowed, or turned under in the green or half matured stage. Commercial fertilizers when used should be applied generally in conjunction with some form of vegetable manure, as barnyard or stable manure, or vegetable matter plowed under.

Inasmuch as stock can be grazed the year round on vetch, rape, rye, oats, Bermuda grass, cowpeas, sorghum, and velvet beans, it would seem that the raising of more live stock would be profitable, particularly when the value of the increased supply of manure is considered.

There are good opportunities for agriculturists in Thomas County. The soils are adapted to a wide range of crops, and good land can be bought at moderate prices. Few sections offer more attractive inducements to the man of small means or to the capitalist desiring to engage in either specialized or general farming.

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SOIL SURVEY OF LAMAR COUNTY ALABAMA.

By E. R. ALLEN, Assisted by W. L. LETT, of the Alabama Department of Agriculture and Industries.

DESCRIPTION OF THE AREA.

Lamar County is located in the northwestern part of the State of Alabama, and the soils, crops, and agricultural practices found there

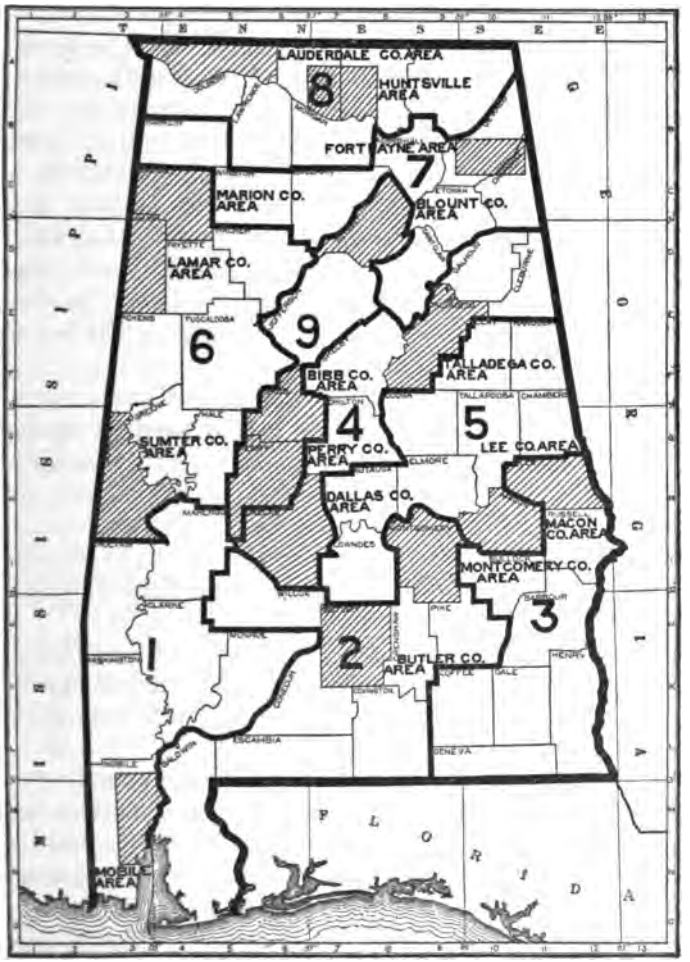

FIG. 10.—Sketch map showing location of the Lamar County area, Alabama.

are representative of a large part of the hill section of the State. Parallel 34° N. and meridian 88° W. pass through the area. The

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county is regular in shape, being almost a rectangle. Its length north and south is 36 miles and its width across the south and north ends is 19 and 15 miles, respectively. It comprises an area of 391,232 acres, or about 611 square miles. It is bounded on the north by Marion County, on the east by Marion and Fayette counties, on the south by Pickens County, and on the west by Lowndes and Monroe counties, Miss.

The topography of the county varies from rolling to almost mountainous. The level areas are very limited in extent. In the eastern half of the county the topography is so rough and hilly that the country is poorly suited to agricultural purposes. In this section the ridges marking the divides between the major streams are from 250 to 300 feet above the water courses. The slopes to Hell, Yellow, and Beaver creeks in the eastern part of the county are so precipitous as to give the valleys of these streams a gorgelike appearance. This rough, hilly portion of the county has been so badly dissected by erosion that it now presents the appearance of a miniature mountain system, with numerous serrated ridges and cross ridges. In the central and western parts of the area, except between Luxapallila and Mud and between Mud and Yellow creeks, the hills are broader and more rounded, and a larger percentage of the country is cleared and farmed. The lowest point in the county is perhaps 200 feet above sea level, while the highest is about 600 feet.

The general course of the streams is to the southwest, into the Tombigbee River, and this determines to a great extent the configuration of the country. Luxapallila and Mud creeks in the southern part of the county, Yellow, Hell, Wilsons, Watson, and Cut Bank in the central, Buttahatchee River and Beaver Creek in the northern, and Sipsey Creek in the northwestern part are the principal streams of the area. These, with their numerous tributaries, furnish ample drainage for the uplands.

Most of the streams have built up rather broad bottoms, and these are generally swampy and uncleared. The movement of these streams is moderate to sluggish, and often no well-defined channel is apparent.

The present inhabitants of Lamar County are nearly all descendants of Georgia and South Carolina settlers, most of whom have come to this part of Alabama since the thirties. There has been a certain amount of emigration to the newer States of the Southwest. Very few of the early settlers were slave holders, and, as a result, the colored population of the area does not form more than 10 per cent of the total. The rough, broken character of the country and the distance from market caused settlement to be slow, and it has been only as a few families came from year to year that the present population has been built up. At present only 325,576 acres is reported

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to be in farms, and of this 94,013 acres, or about 25 per cent of the area of the county, is reported to be improved land. The towns are all small, Sulligent and Millport each having a population of perhaps 600, and Vernon, the county seat, about 300. Kennedy, Fernbank, Melborne, Beaverton, and Crews are small railway towns, while Detroit represents a trading point for the settlements in northwestern Lamar and southwestern Marion counties.

The transportation facilities of the county are rather inadequate. The Southern Railway and the St. Louis and San Francisco furnish handy shipping points for the northern and southern parts of the county, but the farmers in the interior of the county have to haul their products 12 to 15 miles to reach a railroad. In the southwestern corner of the county considerable of the trade goes to Columbus, Miss.

The roads are such as might be expected in a hilly and undeveloped country. In order to avoid changes in topography they usually meander along the crests of the ridges or else follow the valleys. The sparseness of the population prevents the proper working of the roads, and as no machinery at all is used in their repair they often become quite bad during the winter season. The gravel beds which outcrop in the county furnish very good road-building material, but the distribution of these deposits is not such as to warrant their use in all parts of the county.

Birmingham and Memphis are the nearest large cities, the former being 100 miles east and the latter 150 miles northwest of the county. Most of the supplies used in the county are shipped from these points. Cotton is sold on the local markets and shipped to these or more distant cities.

CLIMATE.

The climatic conditions of Lamar County are favorable to general agriculture. The growing season of almost seven months' duration, together with the ample rainfall, makes possible not only a great diversity of crops, but also the production of several crops during one season. Little extreme heat is experienced, instances of the thermometer going above 95° being the exception rather than the rule. The mean temperature for the summer months is 80° F. and for the winter months 45°. The winters are short and mild, freezing temperatures seldom obtaining for more than twenty-four to forty-eight hours. The rivers never freeze and snow occurs on an average of perhaps twice a winter, and seldom remains on the ground for more than twenty-four to forty-eight hours. The rainfall is ample for large yields and is quite well distributed, although during the months of January, February, and March the rains often come in torrents, causing considerable damage in the uplands by erosion and in the bottom lands by overflow. On the other hand, droughts are

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sometimes experienced in July and August, but the effects of these could be minimized by proper tillage and soil management. The spring opens about three weeks later than it does in central and south Alabama.

The appended table, compiled from the records of the Weather Bureau station at Tuscaloosa, gives the normal monthly, normal annual, and the absolute minimum and maximum temperature and precipitation.

Normal monthly, seasonal, and annual temperature and precipitation, etc., Tuscaloosa.

Month.	Temperature.			Precipitation.			
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year.	Total amount for the wettest year.	Snow, average depth.
	°F.	°F.	°F.	Inches.	Inches.	Inches.	Inches.
December	46	75	9	4.8	1.1	4.0	0.2
January	44	78	11	5.6	4.1	3.6	Trace.
February	46	83	— 7	4.8	4.1	5.6	1.0
Winter	45	.....	.....	15.2	9.3	13.2	1.2
March	56	88	17	6.0	5.2	6.1	0.0
April	64	94	30	5.0	4.7	15.7	0.0
May	73	100	40	3.2	3.5	1.4	0.0
Spring	64	.....	.....	14.2	13.4	23.2	0.0
June	79	103	48	4.8	7.0	13.5	0.0
July	82	106	59	4.8	4.0	5.2	0.0
August	80	105	59	3.5	1.2	0.8	0.0
Summer	80	.....	.....	13.1	12.2	19.5	0.0
September	75	101	40	2.2	0.6	3.3	0.0
October	63	92	30	1.8	1.7	5.4	0.0
November	53	88	19	3.0	2.8	4.6	Trace.
Fall	64	.....	.....	7.0	5.1	13.3	Trace.
Year	63	106	— 7	49.5	40.0	69.2	1.2

The average date of last killing frost in spring is March 23 and of the first in the fall is November 6. Date of latest killing frost in spring April 9 and of earliest in fall October 21.

AGRICULTURE.

Lamar County was originally timbered with pine, hickory, and oak. These different trees were distributed in about the same proportions on all types of soil, except that more beech and gum were found in the bottom lands. The early settlers cleared only small tracts, and the agriculture that followed was somewhat primitive, but included a larger variety of crops than the system now in vogue. Only a small number of the early plantations were slaveholding, and none of them comprised extensive tracts, such as are found farther south.

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As the country then was sparsely settled, the farms were usually far apart and each was more or less self-sustaining. The farmer and his family produced everything that was necessary to eat and wear. A few sheep were kept, and the wool that was not used in weaving the cloth for the family was sold with the other products of the farm. Wheat was the principal crop, although corn, oats, potatoes, and tobacco were grown for local use. As transportation facilities were entirely lacking, the few money products were hauled to Columbus or Aberdeen, Miss.

The first settlements were made either on the ridges or in the narrow valleys of the minor streams, where water was at hand. No attempt was made at first to cultivate the bottom and terrace areas, it being thought that they were too wet and swampy for profitable farming. Before the agricultural practices of the area had become very well fixed, however, it was found that by clearing the second bottoms and the bottoms of the smaller streams considerable tracts of good farming land could be obtained, and many settlements were made on these areas comparatively early in the history of the county. At present all the terrace areas are cleared and farmed and looked upon as the best farming lands of the county.

These general conditions prevailed up to the time of the civil war. Continuous cropping to wheat had reduced the yields of that crop, the rust and insects had become more destructive, and in general the profits on this staple had almost disappeared and its production was discontinued. About the time of the war the growing of cotton began. It grew well on the soils, and as it found a ready market it gradually took the place of wheat, until it became the dominant crop of the area. Cotton is now the sole money crop on all soils and all operations of the farm are made subordinate to those necessary in the production of this staple. The extension of railroads into the area has helped to furnish markets for this staple, and as the area of cultivated land has increased continuous cropping to cotton has been the type of agriculture adopted by all settlers.

Corn is next in importance, every farmer planting a portion of his land to it. However, many of them do not produce corn enough for their own consumption, and to supply this deficiency corn, usually of an inferior quality, is shipped from outside points at heavy cost to the consumer. Oats and cowpeas are minor crops, and as the latter do well the acreage planted to them should be increased. No hay is produced, and the roughage for stock consists of corn fodder, only the blades being used. Sugar cane is grown in the southern end of the county, and as the profits are usually large this crop should be more generally planted. No fruit is grown on a commercial scale,

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and but few farmers in the county produce enough even to supply their own needs.

Continuous cropping to cotton reduced the yields, and in order to obtain larger yields some of the farmers cleared up new tracts of land, while others about twenty years ago began to use commercial fertilizers. It was found that the soils responded quite readily to the application of mineral plant food, and this practice, like the growing of cotton—good in itself—grew rapidly and was abused. Farmers began to depend too largely on fertilizers, and cultural methods, already insufficient, were further neglected. The fertilizers used have been almost entirely the high-grade "guanos" analyzing 10–2–2 or 8–2–2. No attempt has been made to maintain the productiveness of the soil by adding organic matter, and as a result fertilizers have come to be considered a necessity. According to the last census $24,210 was expended for commercial fertilizers by the farmers of the county in 1899.

The prevailing system of farming in Lamar County consists in the production of cotton and corn, much of the meat and other necessaries which might better be produced on the farm being purchased. With the dependence placed upon one crop and money coming in but once a year, the farmers are usually obliged to purchase supplies on credit, and thus pay a larger price than if they paid cash. They are also often obliged to market their cotton as soon as picked instead of taking advantage of market conditions.

At present agriculture in Lamar County is not as well developed as that of other sections of the State, but considerable advance has been made within the last ten years, and the practices now in vogue are of a more constructive nature than formerly. This improvement is due partly to the fact that better prices prevail and partly to the recognition that by farming more systematically and thoroughly much larger profits may be obtained. More and better implements are in use, such as disk harrows, weeders, stalk cutters, and two-horse plows. Business is on a firmer basis than formerly and more farmers are paying cash for their supplies. Property values are increasing slightly and this is an incentive to better methods of farming.

Very few cattle and hogs are kept and these are of mixed breeds. Formerly these ran at will through the woods, but now the stock laws prevent this to a certain extent. Very few sheep are seen. In general not enough pork is produced for home consumption, and seldom is there any surplus live-stock products for market. Mules are shipped in from other States, little attempt being made to raise them in this county. Oxen are used quite largely for hauling and to a less extent in farm work.

Terracing to prevent soil erosion was begun about twenty years ago and is now the general practice throughout the county. Terrace

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lines are run, usually by the aid of a level, around the contour of the hills, and the cotton rows in ridges are filled in between and approximately parallel to these terraces. It is recognized that terracing pays, as it not only prevents erosion but serves to distribute the rainfall more uniformly in the soil. Some farmers lay out their terrace lines without the aid of an instrument, and as a result the best effects are not obtained. The terrace line is sure to be low at one or more points, and when heavy rains come the water collects here, breaks over, and a gully starts.

Terracing, while effective, has objections, chief of which is the difficulty of cultivating fields laid out in this way. Where the land is only slightly rolling erosion can be prevented by deeper plowing, the addition of organic matter, and the use of winter cover crops, and as this method leads to the improvement of the soil, as well as to greater ease of cultivation, it should be adopted where possible.

No systematic rotation of crops is practiced. In general cotton follows cotton until the yields fall so low that profitable results are not obtainable, even by the aid of fertilizers, when the fields are abandoned or else allowed to lie fallow for a few years. In the latter case the field is often left unprotected and the damage from erosion is so great that no attempt is made to reclaim it. Some farmers follow cotton with corn and a few plant cowpeas in the corn at the last plowing, and these are either gathered for hay or pastured, but this practice is the exception.

Not much consideration has as yet been given to the matter of adaptation of crops to soils, partly because there is not such a wide variety of soils presented as in some localities. It is generally recognized that the sandy uplands are better for cotton than for corn, while in the narrow stream bottoms the reverse of this seems to be true. The tendency of the cotton on the bottoms is to grow too rank, producing stalk at the expense of the boll, and it is frequently caught by the early frosts. The cotton on these areas is also more susceptible to rust. After several years of cropping to corn these bottom-land soils have their humus content reduced, and will then grow cotton if fertilizers are used, so that considerable cotton is at present produced on the low-lying areas. The areas of Orangeburg sandy loam seem to be peculiarly adapted to cotton. The second-bottom areas and the areas of Norfolk silt loam are moderately well adapted to cotton and somewhat better to corn than the sandy uplands.

The tillage methods are practically the same as those used in general in the hilly sections of the South, and are in many cases inadequate. A light one-horse plow, to which a variety of points may be attached, is used throughout the season. Most of the plowing is done to a depth of 3 or 4 inches. In the preparation of the seed bed the practice of ridging is much more common than broadcast

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plowing. Sometimes, however, the ground is broken with the turning plow and thrown into ridges later. More often a series of furrows are run to open the ridges upon which the plants were grown the preceding year, and then commercial fertilizer, at the rate of 200 to 300 pounds an acre, is drilled in the furrows thus made. The soil is then turned back into its original position. Some farmers claim that by keeping the ridges in the same place in this manner fertilizers can be used more economically, as what is left by one crop is within reach of the succeeding one. Corn is usually drilled in rows about 4 feet apart, and cotton in rows about 3 feet apart. Both are drilled in with a single-row planter. Cultivation is accomplished by hoeing and by stirring the soil with single-shovel plows. The first step in the cultivation of the cotton is known as "barring off," or throwing the dirt away from the plants. This is followed by the hoeing, or "chopping," by which the plants are thinned to one stalk to every 10 or 12 inches.

The labor problem does not assume the importance in Lamar County that it does in regions where agriculture is carried on more extensively. However, during the last few years it has been more difficult than formerly to obtain help, as the laboring class, both white and colored, has sought employment in the sawmills or in the cities. The farms are usually small, the farmers not attempting, as a rule, to cultivate more than they can care for with the assistance of their own families. Most of the land is held in tracts of 160 acres or thereabouts, and of this not more than 30 or 40 acres are under cultivation. According to the census of 1900 only 25 per cent of the area is improved land.

About 60 per cent of the farms of the county are operated by their owners. Thus, the tenant system, so characteristically developed in other parts of the South, is not common in this area. There are practically no large holdings, although some landowners own a number of farms, but these are more likely to consist of a number of small farms rather than one continuous tract that is parceled out and worked by tenants. The rent paid by the tenants is usually "one-third" and "one-fourth;" that is, one-third of the corn and one-fourth of the cotton produced.

Not a large percentage of the farms operated by white owners is mortgaged. Chattel mortgages are very common, however. These are the result of a system of "advancing," which is generally admitted to be a serious handicap to the agricultural interests of the county. Practically all the farmers have to purchase on credit the supplies and tools necessary in production of their crops. To protect himself the merchant takes a mortgage on the farmer's personal property or his crop, and sometimes on both.

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Almost no profitable system of farming can be carried on without a rotation of crops, for experiments and common experience show that there are very few soils, no matter how fertile, that will produce the same crop year after without a diminution in the yields, and a rotation of crops therefore becomes necessary. The standard rotation recommended by the State experiment station would probably be as well as any for Lamar County and is as follows: First year, cotton; second year, corn, with cowpeas sown at the last plowing; third year, oats, followed by cowpeas; fourth year, cotton again. If the crop of peas following the corn is turned under to a considerable depth in the fall, better results will be obtained than if they are cut for hay or pastured, as more organic matter or humus will be added to the soil, as well as the nitrogen that has been gathered from the air by these plants. However, if fall plowing is practiced, it will be necessary to protect the soil during the winter with a crop of rye or vetch or a mixture of these two. As all the soils are subject to more or less washing and leaching during the winter months in this latitude, it is recommended that a cover crop be grown after all crops, and plowed under as early as possible in the spring. All the soils of the area are deficient in organic matter, and this rotation will tend to supply this important constituent, and also nitrogen, which is usually added in the form of expensive cotton-seed meal. Good results will also be obtained from applications of mineral fertilizers.

The home mixing of fertilizers has been found advantageous and can be recommended for Lamar County. The results obtained on the experimental plots of the agricultural school at Hamilton, in the adjoining county, indicate that of the three constituents, nitrogen, phosphoric acid, and potash, nitrogen and phosphoric acid are the more essential. A combination of acid phosphate and cotton-seed meal is the best mixture for supplying these substances. It was pointed out that the rotation recommended would gradually remove the need of cotton-seed meal, so that this expensive ingredient can be gradually eliminated as humus is incorporated into the soil. Rock phosphate is beginning to be used in small amounts, and while this is the cheapest form in which to obtain phosphates, it will give little result the first year, unless used with barnyard or green manure. Where live stock is kept, composting, or the mixing of fertilizers with barnyard manure, trash, etc., should be practiced. Numerous reliable fertilizer formulas are given in the bulletins of the Georgia experiment station, and these publications may be obtained free upon request.

As already pointed out, the plowing is usually only 3 or 4 inches deep. This is generally too shallow to give the best results. The plows are so light that green crops, trash, stalks, etc., can not be effectively turned into the soil. Many of the farmers of the area have plowed to the same depth for so long that a well-defined plow

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sole, impervious to water and plant roots, has been formed by the pressure of the plow upon the base of the furrow. This can easily be corrected by deeper plowing and varying the depth of the furrow from year to year. There is a more or less general prejudice against deep plowing, many of the farmers claiming that it injures the land. Opposed to this is the experience of some of the best farmers of the county who have practiced deep plowing, using care and judgment not to deepen the seed bed too suddenly or to stir the heavier subsoil when it is too wet.

While the general inadaptability of the soils of the county to corn production is unfavorable to the extensive development of live-stock interests, more and better live stock should be kept than at present. Stock should be confined to pastures on the farm instead of being allowed to range at will through the woods.

In connection with the raising of more live stock more grass crops for pasturage and for hay would have to be introduced. Alfalfa can probably be grown with the aid of lime and inoculation, as can several other forage crops, such as crimson clover, vetch, lespedeza, etc. There appears to be no good perennial grass that can be grown for hay except Johnson grass, but the difficulty of eradicating this plant in the cotton and corn fields makes the general introduction of it open to question. Hay can best be produced by the mixing of the various annual forage crops, two crops of which can be very easily grown in one season. Oats and vetch, followed by cowpeas, or by cowpeas and sorghum, furnish good hay. Excellent pastures may be obtained from Bermuda grass, although it does not grow large enough to cut for hay.

SOILS.

Lamar County does not present a wide diversity of soils, by far the greater percentage of them being fine sandy loams in texture; but little coarse or medium sand is found upon the uplands, and only a limited amount of clay.

The soils of Lamar County fall into two general divisions—the upland sedimentary soils and the terrace and alluvial or bottomland soils. Of the former there are eight types and of the latter three. The sedimentary Coastal Plain soils were derived from deposits which were laid down under conditions somewhat different from those existing farther from the boundary line between the Tertiary and the Carboniferous periods, and the types are, therefore, less uniform than where the formations are less variable in their composition. For this reason most of the types could not be correlated with the established series, and those that were correlated varied somewhat from the true type.

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The upland soils are all sedimentary in origin. Three geological formations are exposed, and these give rise to the various soil types of the area. They are the Tuscaloosa of the Cretaceous, the Columbia loam of the Quaternary, and the Lafayette of the Tertiary period. The Lafayette and the Tuscaloosa are made up of unconsolidated beds of sands and clays and pebbles. The Tuscaloosa is the formation which underlies all of the area, and owing to the great amount of erosion that has taken place since the final recession of the waters of the Gulf, the overlying Lafayette has been partly and in places entirely removed. The materials which go to make up these two formations are so similar that absolute identification is impossible. It is probable that the heavy material in the western part of the county which gives rise to the Susquehanna fine sandy loam is entirely Tuscaloosa, while the areas mapped as Orangeburg sandy loam in the eastern part of the county, and occupying the crests of the highest ridges, are entirely Lafayette, but the great majority of the surface materials of the county are composed of a mingling of the two. The Columbia loam formation, which is more extensively developed farther to the west in Mississippi, is exposed in only limited areas in Lamar County, the most extensive of which are near Millport or near the southwestern corner of the county. The material which makes up this formation consists of yellow loam or silt loam. It does not occur at as great elevations as do the Lafayette and Tuscaloosa, has not been subjected to as great an amount of erosion, and is, therefore, more nearly level in topography.

Lamar County lies near the southwestern border of the Cumberland plateau, the old shore line passing approximately parallel to the east county line and about 15 miles to the east of it. The sandstone formations of the plateau are exposed in the northeast corner of the county, where they form the bluffs of the Buttahatchee River for about 1½ miles after it enters the county. They dip slightly to the southwest, and probably underlie the whole area, though they are not exposed, except in the one place mentioned. Owing to this dip the nearer the plateau is approached the greater is the elevation above sea level and the greater the erosion; consequently the eastern part of the county has been so badly dissected by erosion that it now presents a rugged, almost mountainous appearance.

The Coastal Plain materials laid down along the margins were subjected to varying influences during the period of deposition, and because of this the soil-forming material varies widely. In many places thick beds of gravel were formed, while at other points, presumably representing quiet bays, fine material was deposited, resulting in the formation of loams and fine sandy loams. Some of the gravel beds were cemented with iron, forming a conglomerate, while at other

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points the iron compounds acted as a cement between the sand grains, forming a brown, highly ferruginous, and moderately hard sandstone. Farther out the deposition was more uniform, giving rise to the interbedded sands and clays characteristic of the Gulf Coastal Plain. At considerable distance from the old shore line, that is, in the central and western parts of the county, erosion has been less active, and, although all the original surface features have been dissected by erosion, this portion of the county does not present the rough appearance that the eastern section does. Iron crusts occur less frequently, and gravel seams, though present in places, are usually too small to exert any influence upon the surface.

The conditions described have given rise to twelve types of soils. The Guin fine sandy loam is the most extensive type and is predominant throughout the western half of the area. Closely associated with it are the other Guin types. These soils all have the same origin—that is, the Lafayette and Tuscaloosa formations—and as the differences that exist are due to differences that obtained at the time of deposition and to differences in erosion, these four types are naturally quite closely related, and no sharp line of demarcation exists between them, so that the boundary lines as shown are often little more than approximations. The original material of the Lafayette, as mentioned already, consists of red and yellow sands, clay, and loam, with here and there beds and lenses of gravel. The various processes of weathering have altered the surface of these deposits into the present materials. The drainage waters passing over and through this loam and sandy clay material have removed in suspension much of the finer clay particles from the surface, leaving a fine to medium sandy soil. The subsoil for the most part is much like the material of the original beds. Where these weathering processes have formed a surface fine sandy material from 6 to 18 inches deep, the type is classed as Guin fine sandy loam. On the steep slopes of the narrow valleys to the east of Vernon, where erosion and leaching have been more effective, the surface material is more sandy and of greater depth. This soil was mapped as the Guin sandy loam. It will be seen that these types vary with the degree of erosion, and thus the fine sandy loam has a deeper and a more sandy surface on the steeper slopes near the larger streams. Where protected from erosion the sandy loam type naturally assumes the characteristics of the fine sandy loam.

During the processes of weathering some of the iron salts disseminated throughout the deposits were dissolved and, percolating downward, were precipitated. These acted as a cement, forming iron crusts or conglomerates varying in size from a few inches to several feet in diameter. More of this stony material has accumulated on the steep areas, and when sufficiently plentiful to render the soil unfit for

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agricultural purposes the soil is classed as the Guin stony sandy loam. This type is confined almost entirely to the hilly eastern portion of the county. As a result of the outcropping of the beds and seams of gravel and also as a result of the removal in such places of the finer soil particles, we find on the steeper slopes next the larger streams of the eastern part of the county a soil to which the name Guin gravelly sandy loam has been given. It is nowhere extensive and is agriculturally unimportant.

Closely associated with the preceding soils is the Orangeburg sandy loam. It is derived from the Lafayette, and the principal difference between it and the Guin fine sandy loam is in the color of the subsoil. The Norfolk silt loam owes its origin to the weathering in place of the Columbia loam material. The Norfolk fine sandy loam is derived in part from the Columbia loam and in part from the Lafayette and Tuscaloosa materials. The Susquehanna fine sandy loam is derived from the weathering of the heavy clay areas in the western part of the county, which probably belong to the Tuscaloosa.

Since the final recession of the Gulf waters the active erosion of the streams has resulted in the formation of terraces and bottom-land areas along their courses. This has given rise to three types of soil—the Norfolk loam, which exists as terrace areas along the major streams, and the Waverly loam and the Ocklocknee loam, found in the bottoms. The former includes the white swampy soils and the latter the higher lying and better drained areas. All these alluvial soils are composed of materials of Quaternary age, the terraces being Pleistocene and the bottoms Recent.

The following table gives the names and areas of the several soil types shown on the accompanying map:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Guin fine sandy loam	131,776	33.7	Norfolk fine sandy loam	10,560	2.7
Guin stony sandy loam	83,520	21.3	Guin sandy loam	10,112	2.6
Ocklocknee loam	49,152	12.6	Orangeburg sandy loam	9,920	2.5
Waverly loam	41,344	10.6	Norfolk loam	6,784	1.7
Guin gravelly sandy loam	19,264	4.9	Rough stony land	640	.2
Susquehanna fine sandy loam	14,912	3.8			
Norfolk silt loam	13,248	3.4	Total	391,232	.....

GUIN FINE SANDY LOAM.

The soil of the Guin fine sandy loam consists of a light-brown to gray fine sandy loam or sandy loam 10 to 24 inches deep. The surface, to a depth of 6 or 8 inches, when in the virgin state, is light

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brown in color, but owing to methods of cultivation, open texture of the soil, and rapid oxidation in this latitude, the color bleaches to gray or almost white when cultivation has been practiced for a few years. The subsoil is quite variable, as it includes almost every combination of the red and the yellow sandy clay or clay. As a rule no one color or texture extends over any considerable area, but these characteristics bear little relation to topography or position.

This type is somewhat anomalous, and is, in a way, intermediate between the well-established Orangeburg and Norfolk series, typical borings of each of these series frequently being obtained in the Guin fine sandy loam.

At irregular intervals iron crusts and beds of gravel are found in both the surface and subsoil, and where these are of sufficient prominence to warrant a separate classification they have been mapped as either the Guin stony sandy loam or as the Guin gravelly sandy loam.

The Guin fine sandy loam is the most extensive type of the county and is found quite generally distributed, although the largest areas occur in the western half of the county.

The original surface of this soil has been modified by erosion, and the streams have cut deep valleys, so that the present topography varies from heavily rolling to rough and hilly. North of the Buttahatchee River the ridges between the stream courses are narrow and not well suited to agriculture. In the valley of Sipsey Creek, around Sulligent, and west and northwest of Vernon, the hills are lower and more rounded, and therefore better for agricultural purposes. The areas of this type south of Luxapallila Creek are steeply rolling, but can be used for farming.

This soil is derived from the weathering of the sandy clay and loams of the Lafayette and Tuscaloosa formations. The silt and clay particles have been removed by the leaching of the original surface loam material. This process has played an important part in the development of the soil, as on the steeper slopes, where leaching has been more active, the surface sandy material is deeper. Where the vegetation has been removed, erosion has tended in some places to remove the surface material, thus bringing the clayey subsoil nearer the surface. To the west of Vernon this soil has probably been derived from the blending of the materials of the Lafayette, Tuscaloosa, and Yellow Loam formation, for small areas of Susquehanna fine sandy loam and of Norfolk silt loam are found through it.

The native vegetation of this type consisted of oak, hickory, and shortleaf pine. The forests varied from scrubby to moderately heavy growths. At present the only crops grown on this soil are cotton and corn, with an occasional crop of oats. The yields vary considerably, according to the methods of farming, the quantity and quality of fertilizers used, and the length of time the soil has been

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under cultivation. Probably 15 bushels of corn and one-third bale of cotton per acre are average yields for the type.

Rotation of cotton, corn, and cowpeas, deeper plowing, and a more rational and conservative use of fertilizers will lead to larger yields and profits on this soil. Where the sandy surface material is not over 10 inches in depth it is recommended that the depth of plowing be gradually increased until small amounts of the heavier material are mixed with the surface soil. This will render the surface more loamy, more retentive of moisture and fertilizers, and will tend to prevent the rapid oxidation of the humus.

Most of this type can be bought for $5 to $15 an acre, depending upon the state of buildings and other improvements, and the nearness to towns and railroads.

The following table gives the average results of the mechanical analyses of the soil and subsoil of the Guin fine sandy loam:

Mechanical analyses of Guin fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18437, 18439	Soil	0.0	1.9	9.6	42.8	13.6	25.8	6.7
18438, 18440	Subsoil	.2	1.0	7.4	33.4	11.7	25.7	20.7

GUIN SANDY LOAM.

The surface sandy material of the Guin sandy loam varies in texture from a fine sand to a sand and occasionally to a sandy loam. It varies in depth from 15 to 36 inches. Owing to the open structure of the surface soil it contains little humus, and is, therefore, gray to almost white in color. The subsoil is a red to yellow sandy clay, practically the same as that of the Guin fine sandy loam. Bands of gravel occur frequently, and iron crusts are sometimes present.

This soil occurs almost entirely east of Vernon, and occupies the steep slopes of the narrow valleys between the several prongs of Hell and Yellow creeks. The ridges between these valleys are occupied by Norfolk silt loam, Guin fine sandy loam, or by Guin stony sandy loam.

The Guin sandy loam is derived from the same source as the Guin fine sandy loam, with which it is closely associated, the difference between these two types of soil having been brought about by erosion and leaching. The steep topography has caused the finer particles of the original loams and sandy clays to be carried away, leaving the sands as a residue to form the present surface.

The original timber growth on this type consisted of a mixture of the pines and hardwoods, and practically the entire area has been

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left in forest, although the larger trees have been removed to some extent by the lumber companies. When cleared the most of this type erodes quite badly, and the yields are low. Owing to the depth and loose, open nature of the soil it apparently does not retain fertilizers and manures. It is believed that the best use that can be made of this soil is systematic forestry. It is not well suited for general farming, and if seeded to grass it is so sandy that the turf would soon be injured by grazing.

The following table gives the results of the mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Guin sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18435	Soil	0.0	9.9	25.7	29.0	4.6	23.2	6.8
18436	Subsoil	.0	7.7	20.4	25.0	3.9	26.2	17.0

GUIN STONY SANDY LOAM.

The interstitial materials of the soil and subsoil of the Guin stony sandy loam are practically the same as those forming the Guin fine sandy loam, the stony type being separated from the latter on account of its content of iron crusts and its rough, hilly topography. These iron sandstones are not fragments of a bed rock, as is usually the case with a stony loam, but are formed here and there throughout the deposits as the result of a cementing of the sands and gravel by iron compounds. The fragments are irregular and vary from a few inches to several feet in diameter.

This type is most extensively developed in the eastern part of the county, where, being nearer the contact of the Coastal Plain with the Cumberland Plateau, the original surface has a somewhat higher elevation, and erosion has been more active and destructive than where the elevations were lower. A large area of the soil occurs to the southwest of Vernon and northwest of Fernbank, between Luxapallila and Mud and between Mud and Yellow creeks. This development is probably due to the close proximity of the streams to each other and the more complete dissecting of the interstream areas. The last-named areas of the type are not so rough and hilly as are those on both sides of Beaver Creek, in the northeastern part of the county, which are almost mountainous. As this type is for the most part in a wild and timbered state, and as it is naturally closely related to the Guin fine sandy loam, the boundary lines between these two types are little more than approximations.

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The Guin stony sandy loam has been formed from the erosion and weathering of the Lafayette and Tuscaloosa materials. On the steep slopes the sand is usually deeper than on the hilltops. The stony material is usually most plentiful on the crests of the higher and narrower ridges, which owe their existence to the protection thus afforded from erosion.

As already mentioned, the topography of this soil is hilly to mountainous and too steep for cultivation. If it were cleared of its timber, erosion would be very destructive. At present only the occasional broad hilltops are cultivated, and frequently on these the stones have to be removed before cultivation is practical. The forests on this soil are composed of the same species of trees as on the Guin fine sandy loam, although they are usually more scrubby and of lower commercial value. It is believed that the best disposition that can be made of this land is to leave it in forest. The rocky hillsides could probably be used for grapes, but the present lack of markets prevents the extension of this industry.

Large tracts of this soil can be bought for $1 to $5 an acre. Considerable areas are held at present by lumber companies.

SUSQUEHANNA FINE SANDY LOAM.

The soil of the Susquehanna fine sandy loam is a fine to very fine sandy loam, 4 to 12 inches deep. The color is usually light brown to gray, as is the case with Guin fine sandy loam. The subsoil is a red to dull red heavy, waxy clay, and is usually mottled with gray below 24 inches. In the latter case the texture usually becomes heavier with depth. Sometimes, however, the texture is slightly lighter below 24 inches, and no mottlings are seen. Where exposed in road cuts the clay presents a variety of colors at depths of 4 to 6 feet.

Where the subsoil comes near enough to the surface to be reached by the plow, this type is refractory and difficult to cultivate. Where the subsoil material is found in the roads, they become almost impassable, owing to the waxy, tenacious character of the clay. The exposed clay upon drying cracks into irregular cubes, giving rise to the local term "joint clay."

The Susquehanna fine sandy loam is of limited development in Lamar County. The largest areas are found in the western part along the state line, and along the Military road. A few areas are found in various other parts of the county, and throughout the Guin fine sandy loam small outcroppings of this heavy clay are seen, which if sufficiently extensive would give rise to Susquehanna clay. The topographic features are practically the same as those of the Guin fine sandy loam, into which the soil passes gradually. Level or undulating areas rarely occur. Owing to the character of the sub-

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soil and to the steep topography, the rain water does not enter the subsoil, and in times of drought the crops suffer.

It is probable that the clay beds that give rise to this soil are derived from the Tuscaloosa formation of the Cretaceous period, the overlying Lafayette mantle having been removed by erosion.

The original forest growth on this type was pine and scrub oak. Most of the pine of commercial value has been removed, but the scrub oaks and smaller pines remain. Probably not over one-tenth of the area of this soil is under cultivation.

Cotton and corn are the only crops produced, and the yields are frequently too small to pay the cost of production. Fair yields are obtained sometimes, if at the time the seed bed is prepared the moisture conditions are just right, and if during the growing season there is sufficient rainfall, but the farmers complain that the soil is likely to be either too wet or too dry for cultivation, and it is for this reason a difficult soil to handle properly.

It is probable that by using deeper and more thorough cultivation, and by a systematic rotation of crops that will add organic matter to the soil, the yields could be increased considerably, but the wisdom of cultivating this soil, especially the phase that has the subsoil near the surface, will be questionable as long as areas of Norfolk silt loam, Guin fine sandy loam, and like types can be obtained at the prevailing prices. This type can be bought for $1 to $5 an acre.

The following table gives the results of mechanical analyses of the soil and subsoil of the Susquehanna fine sandy loam:

Mechanical analyses of Susquehanna fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18449	Soil	0.0	0.9	0.4	55.2	15.2	18.5	9.6
18450	Subsoil	.4	1.0	.7	20.0	14.1	20.4	43.0

OCKLOCKNEE LOAM.

The soil of the Ocklocknee loam consists of a friable silt loam 10 to 15 inches deep, light to dark brown in color when wet, but becoming somewhat ashy when dry. The soil grades into a gray or gray and yellow mottled silt loam or loam subsoil. The type is found along the higher lying, better drained areas of the large bottoms, and occupies the narrow basin-shaped or valleylike bottom lands of the smaller streams. Usually where the bottoms are more than a quarter of a mile wide, and the slope from stream channel to the base of the hill is slight, poorly drained areas result, and the soil assumes the nature of the Waverly loam. The transition from one type to the

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other is gradual. As the heads of the valley are reached the soil becomes quite variable. Here it occupies a strip about 40 rods wide or less, and is partly colluvial in origin, receiving wash from the adjacent uplands. Borings of silt loam, loam, and even sandy loam, in varying combinations as to soil and subsoil may be obtained. The most recent deposits by the streamlets from the adjacent hills are known locally as "made land," while the higher lying portions are referred to as "hillside bottoms." In areas where the soil is inclined to be wet and "crawfishy," it is a common practice to turn the small lateral streams so that they will deposit their load of sand over various parts of the field to be cultivated, and as this material is worked into the soil by plowing and subsequent processes of cultivation the result is usually found to be quite beneficial.

In the early settlement of the county it was found that small areas of this soil when cleared were inclined to "fall," that is, as the roots of the trees, shrubs, etc., decayed they sank and became so poorly drained as to be worthless. However, as the bottom land was cleared and more material from the hills was washed in, and better drainage provided by the deepening and straightening of the stream channels, the soil became more productive. The successful management of this soil is now so generally understood that good crops are obtained within a year or two after clearing.

This is the best corn soil of the area, and at the present high price of corn it should be planted as largely as possible in that crop. When planted in cotton, the tendency of the plant is to make excessive stalk growth at the expense of the boll. This tendency may be checked in several ways: by liming the soil, by clipping the terminal buds to encourage fruiting, or by using large applications of phosphate, increasing the depth of the seed bed as more fertilizer is used. No cotton-seed meal should be used on areas where stalk is excessive, as this is likely to aggravate this condition.

The natural drainage of this soil is inclined to be poor, but owing to its slightly sloping surface it can usually be effectively drained by artificial means, such as cleaning and straightening the stream channel and by ditching. The area of this soil mapped just east of Henson's Springs in the Buttahatchee botttoms is moderately well drained and all cleared and farmed.

The native timber growth on the Ocklocknee loam consisted of gum, poplar, beech, hickory, and an occasional loblolly pine. Most of this has been removed and that standing should be cut and the land planted to corn.

The crops grown on this soil are cotton, corn, and sugar cane. It is a good general farming soil, and if thoroughly drained almost any crop can be grown on it. In the southern part of the county it is frequently planted to sugar cane. The narrower areas, even those

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that are too narrow to be mapped, are the best for this crop. The sirup is mainly used for home consumption, but any surplus that may be produced finds a ready local market. Cotton yields from one-third to 1 bale, and corn from 20 to 30 bushels per acre.

The following table gives the results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Ocklocknee loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18433	Soil	0.8	8.6	17.9	17.9	4.5	25.9	6.4
18434	Subsoil	.8	11.0	20.3	21.5	4.4	19.7	27.0

WAVERLY LOAM.

The soil of the Waverly loam consists of 8 to 10 inches of white to light-brown silt loam or loam, or, more rarely, fine sandy loam carrying sufficient fine material to cause it to bake or clod if plowed when wet. The subsoil is a white silt to clayey silt, usually marked with yellow mottlings below 24 inches. The degree of mottling is influenced greatly by drainage conditions, and, therefore, is an index to the agricultural value of the soil. When the drainage is poor and the soil in a saturated condition the greater part of the time, the mottling is less marked or frequently lacking, while in the better drained areas it increases till yellow is the predominating color. The surface soil here has a darker color. Where this condition is extensively developed it gives rise to the Ocklocknee loam.

The Waverly loam is found in the wider bottoms of the major streams of the county. Its topography is flat, except where broken occasionally by old channels or stream bayous. Its natural drainage is poor, and as the stream channels are very crooked, and usually clogged with driftwood, the soil is usually in a saturated condition.

The Waverly loam is derived from alluvial deposits, having been laid down gradually in times of the oft-repeated overflows. The material composing this soil has been washed from the adjacent uplands, and is, therefore, reworked Lafayette and Tuscaloosa.

The forest growth on this soil consists of beech, gum, oak, elm, cypress, and loblolly pine, much of which is still standing. Where cleared and farmed frequent open ditches are necessary to remove the surplus water. The clearings are usually of limited extent and scattered and there are no adequate outlets for the drainage water. The soil is apt to remain in a water-logged condition and to give poor yields. If larger areas were cleared, that is, the bottom along a stream for several miles, the main channel cleaned and perhaps straightened, and the numerous ditches turned into this channel,

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the danger from floods would be lessened, and the abnormal conditions now existing in the soil would be overcome. As the soil is farmed it will be necessary to add lime and coarse organic matter. It is somewhat doubtful if the expense incurred in making such improvements would be justified at the present time.

Waverly loam is known locally as "swamp," "flats," or "crawfish land." Very little of it is under cultivation and hence any estimate of the yields is impracticable.

The following table gives the average results of mechanical analyses of the Waverly loam:

Mechanical analyses of Waverly loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18453, 18455	Soil	0.1	2.3	6.5	17.3	15.1	36.7	21.7
18454, 18456	Subsoil.....	.1	4.5	7.1	14.8	14.1	37.1	21.4

NORFOLK LOAM.

The soil of the Norfolk loam consists of a light-brown to yellowish-brown loam, more or less silty in character and 8 to 10 inches in depth. In some places the texture is decidedly that of a silt loam, while in others the soil contains a larger quantity of medium sand. The subsoil, into which the surface soil passes gradually, is more frequently a loam than a silt loam and is usually mottled with gray below 24 inches.

This type occupies only small areas in the county, but because of its productiveness it is of considerable importance. The principal areas of it are found along Buttahatchee River in the northern part and along Luxapallila Creek in the southern end of the county. Smaller areas are found along Yellow and Sipsey creeks in the central and northwestern parts, respectively. It occurs as second bottom or bench areas along the streams at elevations of from 5 to 15 feet above the level of the regular flood plains. Its topography is level except where cut by a few small streams. Occasional poorly drained and whitish areas are found. In these the soil is acid and the growth of crops is likely to be poor. In addition to draining these areas and giving them an occasional deep fall plowing the application of lime would doubtless prove beneficial.

This soil represents alluvial deposit laid down at a time when the streams occupied higher levels than at present. It is derived from reworked Lafayette material.

The areas of the Norfolk loam along Yellow Creek in the western part of the county and along Sipsey Creek in the northwestern part

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have no well-defined terrace lines, the surface being slightly sloping and the soil grading by degrees into the Ocklocknee loam or the Waverly loam.

The original forest growth on this soil was shortleaf and loblolly pine, oak, hickory, and beech. In its natural condition the type was too wet for profitable cultivation, but by clearing, draining, and tilling it has become one of the most desirable farming soils of the area, and is now practically all under cultivation. Its level topography adds much to its value as farming land. The ridge method of cultivation is usually practiced, but it is believed that level cultivation would give better results wherever the drainage conditions are good. An occasional deep plowing in the fall would be beneficial, and as the soil has a tendency to pack the surface should be stirred just as soon as possible after rains throughout the growing season to prevent the formation of a crust. Fertilizers are quite generally used on this type, as it has for the most part been under cultivation for a long time. It responds readily to fertilizers, and is seldom allowed to lie fallow. Some areas contain relatively large quantities of humus, and on these cotton is inclined to produce stalk at the expense of boll. In such cases less cotton-seed meal and more phosphate should be used. Most of this type is valued at about $25 an acre.

The following table gives the average results of mechanical analyses of the soil and subsoil of the Norfolk loam:

Mechanical analyses of Norfolk loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18441, 18443	Soil	0.1	2.2	5.9	21.0	12.3	48.8	9.5
18442, 18444	Subsoil	.1	1.7	4.6	19.2	14.3	44.7	15.2

NORFOLK SILT LOAM.

The soil of the Norfolk silt loam consists of a yellowish-gray silty loam, with an average depth of 7 inches. The particles composing the soil range from very fine sand to silt. The soil is friable and has a peculiar mealy feel. The subsoil is composed more largely of silt, and has, therefore, a greater coherence, though below 24 inches it also is in many cases friable and mealy. The color of the subsoil varies somewhat with the topography and drainage. Where the drainage is good the yellow color continues to a depth of 36 inches, but in poorly drained areas gray mottlings begin to appear at from 18 to 24 inches, and increase with depth. In extreme cases the gray may be the predominating color of the subsoil.

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The principal areas of the Norfolk silt loam are found in the southern and southwestern parts of the county, although several areas occur west of Vernon. It occupies level, plateaulike areas at elevations intermediate between those of the Norfolk loam and the Guin fine sandy loam. The topography is level to undulating, the surface being only slightly eroded by gullies and streams. The drainage of this soil is not always sufficient, and better crops could be secured in many cases if artificial drainage, either by open or tile drains, were provided.

The Norfolk silt loam is derived from the Yellow Loam formation, which is more extensively developed in Mississippi. Erosion has played very little part in the weathering of this formation into soil.

The original forest growth on the Norfolk silt loam consisted mainly of pine and oak, although some black gum, persimmon, and sassafras occurred. This is considered one of the best soils of the area. Corn does very well, yielding on the average about 20 bushels per acre. Cotton produces from one-third to three-fourths bale per acre. Cowpeas are well suited to this soil, and one crop should be plowed under to a good depth in the fall every two or three years. This, with deep plowing, will generally prevent the running together or packing of the soil and also break up the plow sole that is found about 6 inches below the surface in most fields. A crust usually forms on the surface after the soil has been saturated, and the cultivator should be run to pulverize the surface as soon as possible after rains during the growing season. Contouring and terracing are not necessary on this soil and are seldom practiced. The ridge method of cultivation is used by some, but, except on the poorly drained areas, level cultivation will probably give better results.

The yields on this soil do not decline as rapidly as on the sandier hill soils, but commercial fertilizers are quite generally used. Their use in connection with green or barnyard manures and under a system of crop rotation would give larger profits. On the poorly drained areas lime would be beneficial, but it must not be supposed that it will take the place of drainage.

The following table gives the results of mechanical analyses of the soil and subsoil of the Norfolk silt loam:

Mechanical analyses of Norfolk silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
17523	Soil	0.6	2.6	4.2	10.5	6.9	65.3	9.6
17524	Subsoil	.9	2.3	2.4	6.4	3.8	57.2	26.8

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ORANGEBURG SANDY LOAM.

The soil of the Orangeburg sandy loam consists of a fine sandy loam or loam 6 to 10 inches deep. The surface material is principally fine sand, but frequently contains enough silt and medium sand to give it the texture of a loam rather than fine sandy loam. The color of the soil varies from brown to reddish brown and more rarely to gray. As a rule, the surface material carries more humus than the other upland types.

The subsoil is uniformly a brick-red sandy clay, containing an appreciable percentage of silt. For a distance of 6 to 15 inches below the surface soil the material is heavier than below this depth.

The Orangeburg sandy loam occupies limited areas in Lamar County, and is, therefore, unimportant. It is found widely scattered and closely associated with the Guin fine sandy loam. Isolated areas occur in the southern part of the county, northeast of Vernon, and around Sulligent.

The surface varies from rolling to hilly. Occupying as it does the rather flat and undulating ridge tops, erosion, although active, has not as yet greatly modified the surface. The drainage is good and the texture is such that favorable moisture conditions can be maintained by proper management. Terraces are used to prevent erosion.

Around Kennedy and near Holcomb's schoolhouse there are areas that have a nearly level surface and a reddish-brown surface soil, and are very productive. The areas near Blooming Grove church and to the east of Vernon occupy high, rolling ridge tops, and here the soil is subjected to considerable erosion.

The Orangeburg sandy loam is derived from the weathering of the sandy clays of the Lafayette mantle. The difference between the soil and subsoil has been caused mainly by the removal of the finer particles of the former in the drainage waters, which action has varied with the topography.

This type is the best upland soil of the area and is at present all cleared and farmed. It is more productive than adjoining soils which have lighter colored subsoils. The original timber consisted of a somewhat luxuriant growth of pine, oak, and hickory. Cotton is the principal crop at present, and the soil seems to be particularly well adapted to this staple, producing with careful cultivation 1 bale per acre. Fertilizers are generally used and the soil responds readily to moderate applications. Fertilizers apparently have more lasting effects on this soil than on the lighter colored types with deeper sandy surface soils, and for this reason are more profitably used. It is a soil capable of improvement, and the same general recommendations that were made for the Guin fine sandy loam are applicable to this type. Fall plowing has been found to give good results where the

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land was not too rolling. If this is done the soil should be protected with a cover crop during the winter to prevent erosion. The practice of bedding the land into ridges, so generally followed on this type, is open to question, and careful experiments should be made to see whether or not this is more profitable than level cultivation.

The value of the type ranges from $5 to $35 an acre.

The following table gives the results of the mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Orangeburg sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18447	Soil	0.3	15.5	18.5	30.4	2.7	25.9	6.4
18448	Subsoil	.8	11.6	15.1	21.1	4.9	19.7	27.0

NORFOLK FINE SANDY LOAM.

The soil of the Norfolk fine sandy loam consists of a light-brown to gray, occasionally yellowish-gray, fine sandy to very fine sandy loam 8 to 15 inches deep. The subsoil varies from a silt loam to light sandy clay. Below 30 inches the color often becomes light yellow or even mottled gray. In the more rolling areas the color varies from tan to pale orange.

Of limited development in Lamar County, the largest area is found southeast of Millport. A few others are found in the central and northern parts of the county. The Millport area resembles the Norfolk silt loam; the others are more closely associated with the Guin fine sandy loam, and merge gradually into this and other types.

In general the topography varies from rolling to hilly, though it is not so hilly as the Guin fine sandy loam. Most of it requires terracing to prevent erosion. The area southeast of Millport occupies a somewhat dissected table-land, the crests of the ridges being at a lower level than those of the regular uplands. Other areas occupy broad and rather flat ridge tops or else the lower slopes and valley-like country along the streams.

The area of Norfolk fine sandy loam southeast of Millport owes its origin to the erosion and carrying away of the finer particles of the Yellow Loam formation. The other areas are derived from the materials of the Lafayette and Tuscaloosa.

Originally this soil was covered with the same character of timber as the Guin fine sandy loam, but this has been quite largely removed. Cotton yields about one-half bale and corn 15 to 20 bushels per acre.

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The following table gives the results of mechanical analyses of the soil and subsoil of the Norfolk fine sandy loam:

Mechanical analyses of Norfolk fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18445	Soil	0.0	4.6	12.2	22.1	7.5	44.6	8.4
18446	Subsoil	.2	2.5	11.6	17.1	8.9	40.5	18.7

GUIN GRAVELLY SANDY LOAM.

The soil of the Guin gravelly sandy loam consists of loose, open, gravelly sandy material from 8 to 12 inches deep. The subsoil is frequently a red or yellow sandy clay containing 25 to 50 per cent of gravel. Often, however, the percentage of gravel is greater than this, and there is little clayey material, the interstices being filled with fine sand to sand.

The topography of the soil is usually steep and surface drainage rapid, while owing to its loose, open structure the movement of the soil water is free. On the steeper slopes the soil consists of beds of almost pure gravel, the land being of no agricultural value whatever. As the distance from the major streams increases the topography becomes more gentle, and the soil assumes gradually the characteristics of the Guin fine sandy loam. Included with this soil are a few areas in which erosion has removed the sandy material and left the gravel resting upon a stiff waxy clay, similar to that which forms the subsoil of the Susquehanna clay.

Both waterworn pebbles and angular or subangular stone fragments are found in this soil. They vary from the size of a pea to pieces 2 inches or more in diameter. The waterworn gravel is composed mainly of quartz and jasper, and the angular to subangular fragments of chert.

Areas of the Guin gravelly sandy loam occupy the steeper slopes near to the major streams in the eastern part of the county. They are derived from the outcropping of gravel beds, although in some cases the gravel, originally distributed to a greater or less extent throughout the formation, has accumulated on the slopes as the finer particles have been removed by erosion.

The material forming this soil is Lafayette and Tuscaloosa. As the distance from the old shore line increases—that is, as we go west in this county—the beds of gravel decrease in size and the percentage of gravel disseminated through the deposits is generally less. In places along Yellow Creek above Vernon, and along Luxapallila Creek above Kennedy, the gravel is cemented by the iron compounds,

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forming masses of conglomerate often several feet in diameter. In various parts of the county narrow strips of this gravel are found on the slopes, and occasionally on the tops of ridges. These were in many cases too small to be indicated on a map of the scale used in this survey.

The Guin gravelly sandy loam is nearly covered with forests of oak and pine. Its area is small and its agricultural value low. It has little influence on the agriculture of the county.

ROUGH STONY LAND.

Two areas of Rough stony land occur in Lamar County. They are of very limited extent and are found on the bluffs along the Buttahatchee River where it enters the county. They are due to the outcropping of the massive sandstones of the Carboniferous period, which formation is supposed to underlie the deposits throughout the county.

SUMMARY.

Lamar County, lying in northwest Alabama, comprises an area of 391,232 acres, or about 611 square miles. The surface features vary from heavily rolling to rough and broken. The eastern half is made up of a series of sawtooth ridges, and is poorly suited to agriculture, while the western half is not so rough and has a larger percentage of its area under cultivation. The drainage and general slope of the country are toward the southeast.

The climate is favorable to agriculture, both on account of a long growing season and abundant rainfall.

The county is sparsely settled. Vernon is the most important town and the county seat. There are a number of smaller villages along the railroads. The topography of the county is such that agriculture will have to be developed along intensive lines upon small holdings.

Cotton is the main crop, and all operations of the farm hinge on the production of this staple. A little corn is grown on almost every farm. Fenced pastures are practically unknown. Almost all of the farms are small, usually containing about 160 acres, but frequently not more than 15 to 25 acres are cultivated. No hay is produced, and the forage consists chiefly of corn fodder, only the blades being saved.

Little stock is kept and many other necessaries that could well be produced on the farm are purchased.

Shallow cultivation is the rule, and one-horse implements are used. The use of commercial fertilizers at the rate of 200 to 300 pounds per acre is general. Contour cultivation and terracing are employed to prevent erosion.

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Little land is rented and little labor hired, most of the farms being operated by the owners and their families.

Eleven types of soil, not including Rough stony land, which type is of no importance, were encountered. Eight of these types belong to the hilly uplands and are derived principally from the Lafayette and Tuscaloosa formations. The remaining three are alluvial and terrace soils, derived from more recent sediments.

Of the upland soils, the Guin fine sandy loam, which is an intermediate type between the Orangeburg fine sandy loam and the Norfolk fine sandy loam, is the most extensive. The surface is heavily rolling to rough and hilly. Cotton yields from one-third to one-half bale. Land of this character is valued at from $2 to $15 an acre. Closely associated with this type are the Guin sandy loam and the Guin stony sandy loam, which types are found in the rugged eastern portion of the county, and are of little value agriculturally. The Guin gravelly sandy loam occupies only narrow strips on the slopes, and exerts little influence on the agriculture of the county.

The Orangeburg sandy loam consists of a few scattered areas. It is the best cotton soil of the county, yielding one-third to 1 bale per acre. It seems to be less well adapted to the production of corn.

The Norfolk fine sandy loam has a gray surface soil and yellow sandy to fine sandy clay subsoil, and occupies only a few small areas. Its crop value is about the same as that of the Guin fine sandy loam.

The Norfolk silt loam occupies flat plateaulike areas, and because of this favorable topography it is a desirable farming soil.

The Susquehanna fine sandy loam is found mostly in the western edge of the county. Its distinguishing characteristic is its red to mottled, heavy, waxy clay subsoil. It is not well suited to general crops, and when the refractory subsoil comes near the surface it is difficult to cultivate.

Of the alluvial soils, the Norfolk loam, or second bottom type, is the most desirable and the most important. It does not occupy large areas, but all of it is under cultivation, and quite well suited to general crops.

The Ocklocknee loam ranks next in importance, and occupying as it does the higher lying, better drained parts of the first bottoms of the major streams, and the valleylike bottoms of the small streams, it is usually better suited to the production of corn than cotton, and should be devoted to this crop more largely.

The Waverly loam occupies the whitish swampy bottoms that are timbered and subject to overflow. It has little value at present, and can be improved only by the aid of expensive drainage systems.

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SOIL SURVEY OF HENRY COUNTY, ALABAMA.

By GROVE B. JONES, of the U. S. Department of Agriculture, and E. S. PACE, of the Alabama Department of Agriculture and Industries, Assisted by H. L. WESTOVER.

DESCRIPTION OF THE AREA.

Henry County is situated in the southeast corner of Alabama. It is bounded on the north by Barbour County, on the west by Barbour and Dale counties, on the south by Houston County, and on the east by the State of Georgia. The Chattahoochee River, which forms the eastern boundary, separates the States of Alabama and Georiga and is navigable for steamers the entire distance.

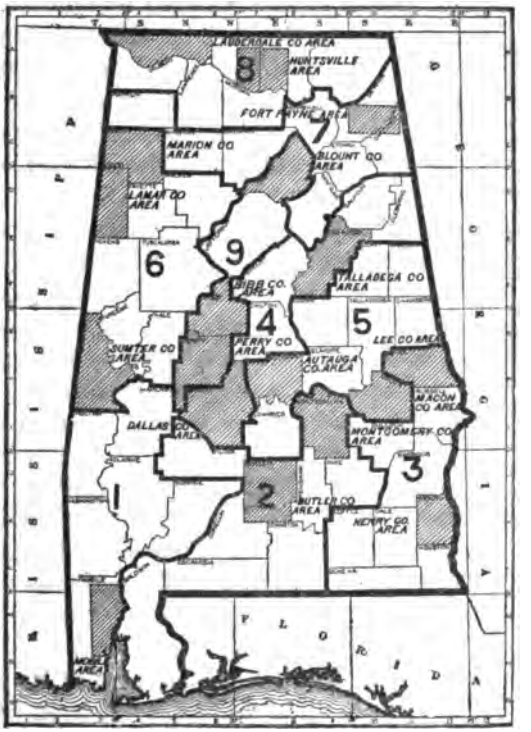

FIG. 11.—Sketch map showing location of the Henry County area, Alabama.

The county embraces an area of 364,800 acres or 570 square miles, and is 32 miles in length, north and south, and 22 miles in width, east and west.

The topographic features are varied. The northern two-thirds constitutes the hilly section and consists of rough, broken, hilly country, with here and there gently rolling areas. Numerous small streams have eroded and gullied this section, imparting to it a choppy contour. "Caves," or holes of considerable depth, with steep perpendicular walls, frequently mark the sources of the streams, which are fed by springs. The southern third of the county is level to gently rolling country, its surface features in some places resembling a dissected plain. A ridge known as "Chunnegee Ridge"

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enters the county at County Line Church and continues south through Lawrenceville and Abbeville, below which place it practically terminates. This ridge forms the drainage divide of the waters entering the Chattahoochee River on the east and the Choctawhatchee River on the west. South from Abbeville the drainage divide between these two rivers may be easily determined by following the direction of the Atlantic Coast Line Railroad. In its entire distance of 25 miles not one stream is crossed. The altitude at the Atlantic Coast Line Railroad depot at Abbeville is 499 feet, but it is believed that the highest elevations in the county are found in the northern part. The elevation decreases southward. At Headland the elevation is 409 feet, and at Grimes, about 2 miles south of the Henry-Houston county line, it is 378 feet, and at Dothan 355 feet.

The county is well watered by numerous springs and creeks. The western part is drained by the Choctawhatchee River through its tributaries, Cowpens, Piney Woods, Indian, Poor, and Blackwood creeks. The eastern part of the county is well drained by the Chattahoochee River. Abbie Creek, a stream of considerable size, flowing into this river, drains the central part, while Omusee Creek drains the southern part.

The Choctawhatchee River does not have much fall, and heavy rains cause it to overflow the level strips of country along its tortuous course. The waters not infrequently divide into numerous shallow channels, and a succession of bridges is necessary where the turnpike roads cross this stream. Before the river leaves the county the channel becomes deeper and the adjacent land is not swampy.

Prior to 1819 Henry County formed a part of Conecuh County, but in that year was set aside. It then embraced all the territory now included in Covington, Dale, Coffee, Geneva, Houston, and the greater part of Pike and parts of Crenshaw and Barbour counties. Within a year or two Covington and Pike counties were formed, and a little later Dale and Coffee counties. On February 9, 1903, the southern part of Henry County was cut off to help create Houston, the sixty-seventh county of Alabama.

The county seat was first located at Richmond, now in Dale County. In 1822 it was removed to Columbia, in what is now Houston County, and in 1833 to Abbeville, the present site.

The first white settlers came from Georgia in 1817 and located in the hilly portion of the present county of Henry. For a great many years the southern level portion of the county remained unsettled. It was considered unhealthy, the soil unproductive, and more labor was required to remove the heavy growth of longleaf pine, which at that time had little commercial value.

The population of the county, as at present constituted, is estimated at 18,000. Abbeville, the chief town, is situated in the north-

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central part of the county. It is located at the terminus of a branch of the Atlantic Coast Line Railroad, which leaves the main line at Grimes, 27 miles to the south.

The population of Abbeville is estimated to be between 1,500 and 1,800 people. The Southeast Alabama Agricultural School is located at this place. It was the first of the agricultural schools to be established within the State and was founded in 1898.

Headland, in the southern part of the county, has a population of about 1,500 and is the only other town of any consequence. Wells and Capps are shipping points for the territory lying between Abbeville and Headland. Haleburg is a small, prosperous village. Small country stores are plentiful.

The transportation facilities for much of the county are inadequate. The branch of the Atlantic Coast Line Railroad, which enters the county 5 miles southwest of Headland and extends north to Abbeville, has a total trackage of 25 miles within the limits of the county. This road, built in 1902–3, furnishes an outlet for the southern part of the county, but in the northern part facilities are very poor. About 2 miles of the Central of Georgia Railway loops into Henry County in the southeast corner, and furnishes an outlet for this section.

Abbeville is the shipping point for crops produced in the north-central part of the county. In the extreme northern part much of the cotton is sold at Eufaula and a little at Clayton, while for the northeast corner Fort Gaines, Ga., is the market. Headland is the market for the southern part of the county.

In the northern part of Henry County the public roads become very muddy and nearly impassable during the wet winter months, but in dry seasons they are in very good condition, except where deep with sand. In the southern part of the county the roads traverse the more level sandy soils and are good, except during dry seasons, when they become deep with sand, making hauling difficult. Generally speaking, the public roads of the county could be considerably improved with material at hand, the sandy clay subsoil forming an excellent surfacing material.

CLIMATE.

The climate of Henry County is generally mild and favorable to winter crops, a greater variety of which could be conveniently and profitably grown. Although occasional cold snaps of short duration occur, when the temperature may go nearly to zero, snow rarely falls and the soil is seldom frozen more than an inch or two in depth.

The summers are long and hot, absolute maximum temperatures during May, June, July, August, and September ranging from 100° to 104° F.

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The rainfall is quite well distributed through the year, although occasional droughts cut some of the crops short. Local thundershowers are of frequent occurrence during the summer.

The following table, compiled from the records of the Weather Bureau station at Eufaula, about 10 miles north of the county line, gives interesting data relating to temperature and precipitation:

Normal monthly, seasonal, and annual temperature and precipitation, etc., at Eufaula.

Month.	Temperature.			Precipitation.			
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year.	Total amount for the wettest year.	Snow, average depth.
	°F.	°F.	°F.	In.	In.	In.	In.
January	47	81	12	3.8	3.5	4.3	0.1
February	50	81	−4	6.7	5.6	7.2	0.5
March	59	88	21	6.1	3.9	7.8	0.0
April	66	92	30	2.7	2.3	3.7	0.0
May	74	101	42	3.2	3.1	5.7	0.0
June	79	101	52	3.9	3.7	2.6	0.0
July	81	104	56	6.7	10.2	3.1	0.0
August	80	103	63	5.6	1.9	10.1	0.0
September	76	100	39	3.0	2.0	11.4	0.0
October	66	94	30	2.5	2.7	1.9	0.0
November	54	83	23	2.9	4.0	1.1	0.0
December	49	82	10	4.0	3.4	5.1	0.0
Year	65	104	−4	51.1	46.3	64.0	0.6

The average date of the last killing frost in spring is March 14, and of the first in the fall, November 9. The date of the latest killing frost in the spring is April 1, and of the earliest in the fall, October 25.

AGRICULTURE.

Henry County has no marked agricultural peculiarities. It is in an old and well-established agricultural section of the South, where the crops and practices to-day are practically the same as for many years past.

The wide difference in the topography of the northern and southern parts of the county has resulted in marked differences in the conditions of the farming class. In the north the rough broken surface has invited erosion, and the fields are in many cases washed and gullied. The central and southern parts are more nearly level, and the farming lands in general in much better condition. In the northern sections the farms are nearly all tenanted; in the central and southern sections more of the farmers operate their own farms. A stretch of nearly level country, lying between Headland and Hale-

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burg, represents the best developed and most prosperous section of the entire county.

Where the tenant system is followed several methods of rental are in use. The most common is known as "standing rent," whereby the renter agrees to pay a stipulated amount of cotton, usually 1 bale for 25 acres, for the use of the land. Under another form of lease the tenant pays the owner of the land one-third of the corn and one-fourth of the cotton. "On the halves" is a popular plan, especially among the large farmers. Under this plan the owner furnishes the land, stock, feed, and seed and pays for one-half of the fertilizer, the tenant paying for the other half. Cash rent ranges from $1 to $3 an acre.

There are comparatively few tenants in the county with sufficient capital to manage independently their business from one season to the next, and they usually receive assistance from the landholder or merchant who "furnishes" or "advances" necessaries incidental to the growing of a crop, against which the charges stand as a lien.

Under such conditions rented farms soon show outward signs of neglect, and as a rule there is a noticeable decline in crop yields; for the tendency under the tenant system is to grow only the money crop—cotton—year after year. This continuous cultivation to a clean-culture crop, without adding to the soil by rotation or otherwise the humus necessary to keep it in good condition, has impoverished the soil of many once productive farms.

Commercial fertilizer was sparingly used as early as 1860–61, and then discontinued until a later period. At present a considerable quantity is used, consisting mainly of cotton-seed meal, acid phosphate, and potash in a 10–2–2 brand. The fertilizer is applied in the spring before seeding or with the seed by means of a one-horse distributer or by hand, using a tube.

As a result of "the fertilizer law," enacted by the State legislature at its recent session, the quantity of fertilizers sold in the State has been increased from 12 to 14 per cent. This applies to mixed fertilizers, acid phosphates with potash, and plain acid phosphate. The law provides that no mixed fertilizer containing less than 1.65 per cent of nitrogen—equivalent to 2 per cent ammonia—shall be sold in the State. Restrictions are also placed upon the character and quality of cotton-seed meal sold for fertilizing purposes, by the provisions of an act passed at the special session of the legislature in November. As a result of this legislation the quality of the fertilizers found upon the market during the present season has been considerably higher than heretofore, though the increase in plant food is chiefly in the phosphoric acid constituent.[a]

[a] Bulletin No. 24, Alabama Department of Agriculture and Industries.

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The crops grown are cotton, corn, peanuts, sweet potatoes, sugar cane, cowpeas, cantaloupes, watermelons, and small quantities of truck and small fruits.

Corn has a large acreage, but it is usually planted on land which has ceased to produce good yields of cotton. The yields of corn, therefore, are not what they should be. Corn is grown solely for feeding on the farm, but only a few farmers produce enough for their own use, and the majority have to buy a whole or a part of their supply at high prices. The acreage devoted to corn could be profitably increased for the purpose of providing feed for the work stock alone, and if the stock-raising industry is to be built up it will be necessary to produce still greater supplies of this valuable feed.

Cotton is to-day, as it has long been, the staple and money crop of the county, and it is grown often to the exclusion of the subsistence crops. Many farmers are compelled to buy corn, oats, hay, and even meat, all of which could be profitably grown in conjunction with cotton, providing for rotation and, through this means, for the improvement of the soil. By systematic and thorough cultivation and seed selection one-third of the land now devoted to cotton can be made to produce as much cotton as the present acreage. The other two-thirds is capable of and should be used for the production of forage, fruits, vegetables, and meat required for home consumption, with some surplus to sell. Cotton is grown in all parts of the county and on each of the several soil types. The wilt disease is quite troublesome in some sections and is especially injurious upon the Norfolk sand and the Norfolk sandy loam. On soils having the red sandy clay subsoils the crop is not so susceptible to this disease.

Oats, mainly rust-proof varieties, are profitably grown, but the acreage is small. Few are thrashed, being fed in the sheaf. The Burt, Red Rust-proof, and Appler are considered good varieties. The "open-furrow" method of sowing oats is in quite general use in the county.

Sugar cane is extensively grown, principally for home use and for the local markets. The horsepower sugar-cane press is to be found on the average farm. The crop is usually planted on small areas of bottom land or in depressions in the other types of soil.

Peanuts occupy a relatively large acreage, from 12,000 to 15,000 acres. They are frequently planted with corn, one row of peanuts and two rows of corn. Peanuts yield from 40 to 75 bushels per acre, and as many as 115 bushels per acre are sometimes produced. They sell for $1.25 a bushel wholesale and for $1.50 retail. Peanut-vine hay yields from two-thirds ton to 1 ton per acre and brings from $15 to $18 a ton, baled.

One farmer near Headland plants from 50 to 75 acres in peanuts each year, and finds them a very profitable crop. From 55 acres of

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peanuts he last year sold $600 worth of nuts, $450 worth of hay, and fattened $750 worth of pork, an average of $32.73 per acre. Besides this he had a splendid volunteer stand of peanuts this year, from which he expects to realize at least one-half ton of hay per acre, besides fattening a large drove of hogs.

The Spanish peanut is grown. This is a much earlier variety than the North Carolina peanut. Planted in March it is suitable for hog pasture by August 15.

The bulk of the peanut crop is not harvested in the usual way, but hogs are turned into the fields and allowed to eat the nuts. This practice is a very common method of fattening hogs. The acreage of peanuts could be very profitably increased, as the nuts and hogs are all sold in local markets and the supply falls far short of the demand.

More attention is being given to the raising of hogs for home consumption and local markets. There is always a strong demand for pork and it can be produced very cheaply. A few farmers kill as many as 100 hogs a year, all of which go to supply the home markets. Every farmer should produce a little meat for sale. Vetch, rape, and winter cereals will produce an abundance of winter grazing for hogs and other stock.

Alfalfa is without doubt the most valuable of the hay crops, and is suited to every class of stock. It has strong feeding qualities, produces heavy yields, and is a splendid soil renovater. The upland soils of the county are as a rule not adapted to alfalfa, but the Cahaba clay is undoubtedly well suited to this valuable crop.

Alfalfa requires a strong, well-drained soil with the water line at least 2½ feet from the surface. Thorough preparation of the soil and careful management in the early stages are necessary for securing the best results. It does best on inoculated soils. After thoroughly preparing the ground add about 400 pounds of soil from an alfalfa field and 200 pounds of bone meal. Drill in 25 pounds of alfalfa seed to the acre in rows 20 inches apart. October or November is the time to plant. From 3 to 5 cuttings can be made each year.

Hairy vetch grown with some of the winter cereals, oats or rye, makes a very good quality of forage. In September or October it will be found profitable to sow broadcast a mixture of rye or oats and hairy vetch, equal parts, in the cotton field. As these are winter crops, they will furnish winter grazing and may be cut for hay or turned under in the spring, thus adding humus in the form of "green manure."

While the importance and necessity of crop rotation is recognized by the majority of farmers, little attention is given to this practice, or to increasing the productiveness of the soil. Some of the best farmers make an attempt to rotate crops, but no system is followed on account of the large acreage of cotton. When any rotation is

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attempted the common practice is to grow cotton from two to three years, followed by corn from one to three years. This system of rotation is the simplest and best suits the man who does not wish to keep live stock. The clean-culture summer crops, cotton and corn, rapidly exhaust the humus in the soil, and should be followed by some winter-growing legume such as vetch or bur clover. This would provide an abundance of excellent winter feed for the farm animals and at the same time increase the producing capacity of the soil by adding nitrogen, at a great saving in the amount expended for commercial fertilizers. More satisfactory rotations involve the use of a greater diversity of crops, and cotton is made more of a surplus crop and the income is distributed over a greater part of the year. The following rotation is recommended: Cotton the first year; corn and cowpeas and winter oats or rye and vetch the second year, followed by cotton the third year.

Dairying is carried on in a limited way in the southern part of the county and some good stock is kept.

The opportunities for developing the dairy business in Henry County are very good. Pasture may be had for the greater part of the year and a great variety of forage crops can be cheaply produced. In a country so dependent on outside help to fertilize the soils dairy farming will be found highly beneficial. It distributes the income from the farm quite evenly throughout the year.

Besides supplying the home markets, first-class dairy products are in constantly increasing demand and good markets could be found in the near-by towns and larger cities.

Cattle and sheep raising in the early years was an important industry, but now there are relatively few cattle and not over 100 head of sheep in the county.

The data as furnished by the United States Census of 1900 apply to Henry County before it was divided and have no real value in this report. The estimates herein given have been gathered from the most reliable private sources.

The size of farms varies from 40 acres to a thousand or more, but farms of several hundred acres are most common. The larger holdings are to be found in the northern and middle parts of the county. The average size is probably 160 acres. From 20 to 50 per cent of the farms are operated by the owners. Rail and more recently wire fences are used when inclosures are needed, but for the most part fencing is unnecessary.

Except in the case of the smaller farms, where the farmer and his family do the work, most of the farm labor is performed by negroes. Wages range from $10 to $15 a month with board. For chopping cotton this year (1908) 65 cents an acre was the price usually paid,

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the hand boarding himself. Day laborers receive from 75 cents to $1 a day.

The saving effected by modern machinery is gradually becoming recognized. Cotton planters, cultivators, fertilizer distributers, and manure spreaders were noticed upon the farms of a few of the more progressive farmers. The gasoline engine is used by enterprising farmers for ginning, grinding, and sawing purposes. The saving by this power over horse, man, or steam power is estimated to be from 20 to 50 per cent.

Small water-power mills along many of the small streams gin the cotton and grind the grain for their respective localities. Considerable water power could be profitably developed on Abbie Creek along the last few miles of its course.

The price of land has increased greatly within the last few years, in some sections from 25 to 200 per cent. The best lands convenient to the railroad sell at $15 to $50 an acre. Lands in the northern part of the county bring from $8 to $15 an acre, while the Norfolk sand may be had for $5 to $10 an acre. The river-bottom soils range in price from $10 to $25 an acre, the Cahaba clay commanding the highest price.

The year 1908 marked the beginning of the growing of cantaloupes and watermelons in Henry County upon a commercial scale. The new industry is at present confined to the southern part of the county, principally near Headland, where several farmers cultivated an area aggregating 170 acres of cantaloupes and 270 acres of watermelons. The fields ranged in size from 5 to 40 acres in the case of cantaloupes and from 10 to 125 acres in the case of watermelons.

It costs from $11 to $16 an acre to produce cantaloupes, depending upon the quantity of fertilizer used. Cantaloupes are planted the first part of March and are ready for the market by June 10. They are shipped in crates which hold 45 of the standard size melon or 54 of the "pony size." The Rockyford is almost exclusively grown.

By organizing and shipping in carload lots the growers have secured fairly suitable rates and facilities. The first shipment of cantaloupes was made to Pittsburg June 12. Prices ranged from $1.50 to $2.50 a crate during the present season. The first shipment of watermelons was made June 18, and as a rule fairly good profits were received from the crop. Besides producing a crop of cantaloupes, some growers made the land produce a crop of cowpeas and a crop of hay.

The 1st of May, or two months after the cantaloupes are planted, cowpeas are sown between the rows and one cultivation given them about a week or two later. After the peas ripen they are cut and thrashed for seed, the yield ranging from 10 to 20 bushels per acre. The yield of peavine hay is one-half ton to 1 ton per acre. By Sep-

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tember a volunteer crop of native grasses can be harvested, from 1 to 2 tons of hay per acre being secured.

The trucking industry, if systematically developed, will, without doubt, prove a source of a large income to the county. The success attained this year will doubtless result in a considerable increase in the acreage devoted to these crops and also act as an incentive for growing other highly profitable truck crops.

Peaches do well in this part of the State, but there are few grown, and little attention is given the trees. With proper methods peach growing on a commercial scale might prove remunerative. The Orangeburg sandy loam is well adapted to the peach, and upon a soil similar to it in central Georgia the peach industry has been very successfully developed.

Notwithstanding that there is quite a wide range in both the texture and topographic position of the soils of Henry County, offering unlimited opportunities for diversification and specialization of crops, few have recognized this fact. Diversification offers the most potent means for the improvement and permanent upbuilding of the soils. It will make possible the rotation of crops, with the inclusion of legumes as a matter of course, and this will favor the keeping of more live stock, an important factor in keeping farm lands in the best possible condition. With the introduction of new crops, the necessity for improved machinery of various types will become more obvious, and its use will greatly increase the producing power of the soil. Thus the future development of the county agriculturally depends upon diversification. A movement in this direction has already been started, and there is every reason to believe that conditions in the county will show great improvement in the next decade.

SOILS.

Henry County is located within the Gulf region of the physiographic province of the United States known as the Coastal Plain, the soil materials of which region were laid down either beneath the water or along the margins of an ancient sea which one time covered this general plain region. In Henry County the Lafayette formation for the most part has contributed the material giving rise to the soils.

In a general way the northern half of the county represents the hilly section of the State. It is underlain by the characteristic stratum of compact red sandy clay of varying depth, which gives rise to the Orangeburg series. At Clayton, in Barbour County, to the north, well borings disclosed the red clay to be about 40 feet in thickness. Underlying this red stratum was found 80 feet of yellow clay resting upon 90 feet of blue marl.

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The Orangeburg, Norfolk, and Susquehanna series occur in this section of the county, the former predominating. Quartzite gravel in small deposits occurs in this formation, being so abundant in local areas as to give rise to two distinct types of soil—the Orangeburg gravelly sandy loam and the Norfolk gravelly sandy loam.

The materials left upon the recession of the sea have been variously modified by processes of weathering, particularly erosion and chemical change, which have given rise to the several types of soil. In some places the fine soil particles have been washed out and carried off by wash, leaving deep layers of sand; in other instances the finer materials have been translocated from the surface portion to the lower portion by the percolating action of rain water, leaving soil types with light surface soils and heavy subsoils; while again the oxidation and hydration of the chemical components, especially iron, has given rise to variety in color. Poor drainage conditions have caused the accumulation of dark-colored organic matter in soils, giving rise to the dark-colored types.

The Norfolk soils with their characteristic yellow subsoils predominate here, although level areas of a red sandy loam (Greenville sandy loam) occupy a considerable extent of territory. The characteristic red material forming the subsoil of the Orangeburg series when present in this section of the area occurs only as a thin stratum overlying the yellow sandy clay.

The Greenville sandy loam is derived from the Lafayette material, and apparently differs from the Orangeburg mainly in the reddish color and higher content of fine material in the soil portion.

The Susquehanna clay, characterized by its mottled, plastic subsoil, is derived from material deposited over the older underlying Cretaceous and beneath the strata giving rise to the Orangeburg, Norfolk, and Greenville series.

Along the larger streams and extending back from their courses to altitudes up to 100 feet occur gray sands, which have been mapped as Norfolk sand.

The soils bordering the Chattahoochee River are alluvial in origin and belong to the recent age, consisting mainly of material transported from the Piedmont section to the north. These deposits have given rise to three members of the fertile Cahaba series, which occurs as terrace soils along several of the larger Alabama streams. The types on the higher terraces are now either above overflow or subject only to occasional inundation at very high water.

The alluvium or Swamp consists mainly of the washings of the upland and varies in texture from a sand to a clay mixed with a considerable amount of vegetable matter. This low-land material is subject to extremely poor drainage conditions.

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The following table gives the names and extent of the several types of soil:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Norfolk sand	128,768	35.3	Norfolk gravelly sandy loam	2,816	0.8
Orangeburg sandy loam	85,888	23.6	Cahaba fine sand	2,816	.8
Norfolk sandy loam	42,688	11.7	Norfolk fine sandy loam	1,024	.3
Orangeburg sand	37,312	10.2	Cahaba sandy loam	960	.2
Swamp	30,720	8.4	Portsmouth sandy loam	704	.1
Greenville sandy loam	19,200	5.4	Ocklocknee loam	640	.1
Cahaba clay	4,800	1.3			
Susquehanna clay	3,264	.9	Total	364,800	.....
Orangeburg gravelly sandy loam	3,200	.9			

ORANGEBURG SANDY LOAM.

The surface soil of the Orangeburg sandy loam consists of a gray, brown, or reddish-brown sandy loam from 12 to 20 inches deep. The subsoil is a red or reddish-yellow sandy clay, the color corresponding to the shades of the soil. The red sandy clay is underlain by mottled clay and cross-bedded sands at various depths ranging to 20 feet.

In the northern part of the county the surface soil of the Orangeburg sandy loam is somewhat lighter in color and texture, being a gray or light-brown sand or light-textured sandy loam, resting upon a reddish-yellow clay formation.

In this broken section the subsoil is heavier and when wet is plastic, the percentage of sand being less and consisting of the finer grades. Frequently considerable silt and finely divided mica scales are contained in it. On the slopes the soil is shallow or in many cases lacking, while on the less rolling areas the soil is deeper. The line of contact of the soil and subsoil is sharp.

Except in the section just described, the surface soil is a brown or reddish sandy loam with an average depth of 15 inches, underlain by a very red sandy clay. Both soil and subsoil contain small iron concretions. The greater part of the Agricultural School experiment farm, at Abbeville, is located upon this type of soil.

The Orangeburg sandy loam is found throughout the county, but principally in the northern two-thirds of the county. The most extensive area is in the northern part, the area stretching northward into Barbour County. The soil is usually associated with the Norfolk sandy loam or Norfolk sand.

The soil is found at all elevations, and for the most part the surface is hilly to rolling, with some few undulating areas. On account of its topography the natural drainage is very good. In places the drainage is excessive, and here much of the surface soil has been

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eroded away, exposing the underlying red clay and even the deeper mottled strata.

The Orangeburg sandy loam owes its origin to the Lafayette formation. It is considered the best upland soil for general farming and an especially strong cotton soil. The average yield ranges from one-third to two-thirds bale per acre, with an application of about 200 pounds per acre of complete fertilizer. By more careful methods a few growers secure a yield of 1 bale per acre.

Corn with 100 pounds of fertilizer yields from 12 to 20 bushels per acre. Oats produce well, and when planted by the "open furrow" method withstand the severest freezes with little or no injury. The yield is estimated at 15 to 30 bushels per acre.

The Orangeburg sandy loam is especially well adapted to the production of Cuban filler tobacco, and upon the same kind of land in Florida the growing of this type of tobacco has been very successful. The filler leaf is grown in the open. The yield ranges from 600 to 800 pounds per acre, and the leaf brings from 20 to 25 cents per pound, depending upon the quality.

The methods of cultivation practiced upon the Orangeburg sandy loam are frequently inadequate to secure the best results. Deeper plowing should be generally practiced, a depth of at least 10 inches being desirable. By more careful and thorough preparation of the soil and systematic crop rotation, including some of the legumes, the productiveness of the Orangeburg sandy loam could be greatly increased. Much of it supports a forest of pine, hickory, and oak. Land of this type of soil can be had for from $10 to $30 an acre, depending upon the location.

The following table gives the average results of mechanical analyses of samples of this type of soil:

Mechanical analyses of Orangeburg sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18799, 18801	Soil	1.8	14.9	13.7	32.1	14.3	15.3	7.7
18800, 18802	Subsoil	.6	8.3	5.5	18.3	9.2	17.8	40.2

ORANGEBURG GRAVELLY SANDY LOAM.

The surface soil of the Orangeburg gravelly sandy loam is a brownish-gray or reddish-brown, medium to coarse sandy loam from 6 to 12 inches deep, containing from 15 to 60 per cent of gravel. The subsoil is a heavy red sandy clay carrying a small percentage of iron concretions, but usually no gravel. The gravel consists mainly of

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waterworn quartzite pebbles, ranging from one-half inch to 3 inches in diameter. There are also present in the soil small iron concretions in varying quantities.

The surface is thickly strewn with this gravelly material, and the gravel content is not usually mixed with the soil, as in the case of the Norfolk gravelly sandy loam. The surface of the crystalline gravel is stained brown and red by iron salts, but the inside of freshly broken fragments is usually white, rose, or purplish in color.

Areas of the Orangeburg gravelly sandy loam are scattered through the rolling section of the county, and the soil is most typically developed in the vicinity of Abbeville. The areas are small and occupy ridges, knolls, slopes, and now and then gently rolling stretches. The soil is closely associated with the Orangeburg sandy loam, and is practically the same soil with the gravel content added. It also occurs associated with the Norfolk gravelly sandy loam, and a definite boundary between these two types is often difficult to establish, practically the only difference between the two being the color of the subsoil, which grades imperceptibly from the one to the other.

The surface features of this soil give it excellent drainage, while the gravel content tends to conserve moisture by preventing evaporation.

An area north of Capps forms the one variation found in this soil. It differs from the typical soil in that the gravel, instead of being waterworn quartzite pebbles, consists of square angular fragments of chert, derived from a hard flinty limestone known as the Knox dolomite.

The Orangeburg gravelly sandy loam is derived mainly from the Lafayette formation. The quartzite gravel and the other rock fragments are evidence that the material was originally transported from the Piedmont Plateau.

Crop yields on this soil are about the same as upon the Orangeburg sandy loam. It is a strong soil and nearly all under cultivation. It is almost invariably planted to cotton. Peaches would undoubtedly do well. The native forest growth consists chiefly of longleaf pine, oak, and hickory.

The following table gives the results of mechanical analyses of this type of soil:

Mechanical analyses of Orangeburg gravelly sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18809	Soil	2.9	15.5	16.9	35.4	8.6	12.0	8.7
18810	Subsoil	2.0	11.9	9.8	29.7	6.3	13.3	26.8

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ORANGEBURG SAND.

The Orangeburg sand consists of a dark-gray or brownish, medium to fine loamy sand, from 6 to 15 inches deep, underlain by a red sand or light-textured reddish sandy loam to a depth of 36 inches. In some places this red material, near the bottom of the soil section, changes in texture to a sandy clay, closely resembling the subsoil of the Orangeburg sandy loam.

This type occupies gently rolling areas, and as found in Henry County occurs in two distinct phases. The phase above described represents the heavier, stronger soil and is nearly always found associated with the Orangeburg sandy loam. The lighter phase occurs very closely associated with the Norfolk sand and differs from it only in one respect, the color of the deeper subsoil.

The soil is a gray or light-brown medium to fine loamy sand, with an average depth of about 12 inches. Underlying the top soil is a yellow or gray sand of similar texture but less coherent, owing to the absence of organic matter. This yellow sand changes to a red sand at varying depths, depending upon the depth of the surface soil, the stratum of yellow sand, and the proximity to areas of Orangeburg sandy loam.

In extent of area the two phases of the Orangeburg sand are about equal, the heavier phase being principally confined to the northern part of the county. Areas occur scattered throughout the county. The larger bodies are found west of Abbeville and east of Wells. Areas of this soil, when found occupying a position between the Orangeburg sandy loam and the Norfolk sand, often represent a gradation from one to the other, and hence are not uniform in depth. The greater depth to the red material distinguishes the sand from the Orangeburg sandy loam, while the red color if within 3 feet separates it from the Norfolk sand. The fine grades of sand predominate, but to the north and northeast especially the proportion of coarser grades is greater. The soil may contain some small iron concretions, but these are never very numerous. Small mica fragments are also sometimes present.

The Orangeburg sand, occupying as it does gently rolling country, is a well-drained soil. Erosion has formed deep gullies in some places, exposing the red sandy material to considerable depth.

In origin the Orangeburg sand is traced to the sands and clays of the Lafayette covering. The lighter phase evidently represents materials which have not suffered so much weathering as the Norfolk sand.

Most of this soil is under cultivation, being planted to the staple crops—corn and cotton. The heavier phase produces yields which favorably compare with those produced upon the Orangeburg sandy loam. The sandier phase is not so productive, especially in droughty

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seasons; still, fair yields are the average. Corn yields from 10 to 12 bushels per acre on this light phase and is more profitable than cotton. As a whole the type is more productive than Norfolk sand, and cotton grown upon it is less susceptible to disease. The Orangeburg sand is naturally suited to truck crops, and all kinds of vegetables and small fruits do exceptionally well.

Like the Norfolk sand, the Orangeburg sand under cultivation soon becomes deficient in humus, and cultural methods should be directed toward the addition of organic matter and the conservation of moisture.

The native timber growth consists of oak, hickory, sweet gum, and pines.

The following table gives the average results of mechanical analyses of samples of this type of soil:

Mechanical analyses of Orangeburg sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18805, 18807	Soil	3.7	26.1	24.9	32.7	3.5	5.2	3.9
18806, 18808	Subsoil	4.5	22.1	22.3	35.1	3.7	4.4	7.8

NORFOLK SANDY LOAM.

The Norfolk sandy loam soil consists of a dark-gray or light-brown sandy loam from 10 to 15 inches deep. The sand consists of medium and fine grades, with varying quantities of small iron concretions and ironstone pebbles. The subsoil is a yellow sandy clay or heavy sandy loam, which extends to a depth of 36 inches or more.

Easy to cultivate and having an open structure, which permits of free movement of moisture, this soil is a warm, early type. As found in Henry County it has incorporated with it a relatively high percentage of humus, which imparts a darker color and makes it more loamy in texture, qualities which the type does not usually possess to such a marked degree. It is therefore more productive, more retentive of moisture, and more responsive to fertilization than in many other areas where it has been mapped.

The principal bodies occur in the extreme northeast corner of the county, at Capps and Wells. Other areas of less extent occur in all parts of the county.

The Norfolk sandy loam occupies level to gently rolling areas, which are well suited for cultivation.

The natural drainage is good, owing to topography and light texture. A few small, low-lying areas, adjacent to streams, principally in the northwestern part of the county, would be greatly benefited by artificial drainage. These flat areas have a shallower and darker

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colored surface soil, a higher organic matter content, and a more loamy texture. The subsoil also contains less sand than is found in the typical areas, and in general is a rather heavy yellow clay.

The Norfolk sandy loam owes its origin to the Lafayette formation, being the weathered product of the sands and clays of this extensive Coastal Plain formation.

The soil is naturally productive and is well suited to the growing of the general farm crops, corn, and cotton. Corn yields from 10 to 20 bushels, cotton from one-fourth to one-half bale, and oats from 10 to 25 bushels per acre.

Bermuda grass makes splendid pasture. Peanuts, cowpeas, and some sorghum are grown as forage crops. Velvet beans, vetch, and rye grow readily and should be added to the forage crops now produced. The first two of these crops add nitrogen to the soil and all three tend to improve its productiveness by replenishing the supply of organic matter, opening the structure, and increasing the capacity for retaining moisture. Alfalfa has been successfully grown upon Norfolk sandy loam in other sections of the south by inoculating the soil. This may be done by applying soil from an old alfalfa field.

Upon the Norfolk sandy loam in Florida and Georgia Sumatra wrapper leaf tobacco is being grown to some extent under shade. It is believed that this industry could be successfully introduced in Henry County, since the climatic conditions are very similar to those of the districts where the industry has been a success. For producing the best quality of leaf those areas should be selected in which the texture of the soil is rather fine and the depth to the clay not less than about 10 inches, nor greater than 20 inches.

For the upbuilding of this soil and the maintenance of humus and natural productiveness, deeper plowing, crop rotation, and the growing of more leguminous plants are recommended.

The price of the Norfolk sandy loam ranges from $10 to $25 an acre, except at Headland, where $50 and more is asked. Most of the type is cleared and cultivated.

The original timber growth consists of pine, oak, sweet gum, and hickory.

The following table gives the average results of mechanical analyses of samples of this soil type:

Mechanical analyses of Norfolk sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18783, 18785	Soil	2.4	17.7	14.8	27.9	11.2	19.1	6.6
18784, 18786	Subsoil	1.1	14.6	13.1	26.1	11.2	16.0	17.8

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NORFOLK GRAVELLY SANDY LOAM.

The surface soil of the Norfolk gravelly sandy loam is a brown or dark-gray gravelly sandy loam from 10 to 15 inches deep. The sand particles are medium to fine in texture, and form a matrix in which the rounded pebbles are generally evenly mixed.

The gravel consists of waterworn quartzite pebbles, ranging from one-eighth of an inch to 3 inches in diameter. As much as 50 per cent of gravel is found in the soil in some places, while varying quantities of the gravelly material are strewn upon the surface.

The subsoil is a yellow sandy clay also containing quartzite gravel to a depth of 2 feet, although there is less of such material in the subsoil than in the soil. In some places little may occur, while in others it may be scattered through the clay in veins or pockets.

Areas of Norfolk gravelly sandy loam, which is not an extensive type, are found chiefly in the east-central part of the county and to the south of Murphree. None occurs in the northern or northwestern part of the county. The soil is closely associated with the Norfolk sandy loam and Norfolk sand. It bears practically the same relation to these two soils as does the Orangeburg gravelly sandy loam to the sandy loam and sand of the Orangeburg series.

The Norfolk gravelly sandy loam occurs as rounded ridges, slopes, and gently rolling areas of small extent. The soil is well drained, and its texture makes it early and easily cultivated. It is derived from the Lafayette mantle.

Cotton is the principal crop, the yields ranging from one-third to one-half bale per acre, and land of this type of soil is nearly all under continuous cultivation to this crop. Originally the soil supported a mixed forest of pine and hardwoods.

The following table gives the results of mechanical analyses of this type of soil:

Mechanical analyses of Norfolk gravelly sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18789	Soil	4.9	17.8	16.8	36.2	7.0	11.6	5.6
18790	Subsoil	3.6	14.5	9.9	24.7	4.7	10.8	31.9

NORFOLK FINE SANDY LOAM.

The surface soil of the Norfolk fine sandy loam consists of a fine sand or fine sandy loam, the upper layer usually darkened by the presence of organic matter, but grading into a yellowish color. In depth it varies from 10 to 34 inches, with an average of about 22 inches. The subsoil is a bright yellow sandy clay, or heavy sandy

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loam, the sand grains being usually somewhat coarser than in the soil. As mapped in Henry County the type includes a few very small areas of poorly drained silt loam.

The Norfolk fine sandy loam is of minor importance, as only five bodies, less than 2 square miles in all, were mapped. All of these are found in the southeast part of the county, in the third bottom of the Chattahoochee River.

With the exception of a few small depressed areas the Norfolk fine sandy loam has excellent surface drainage, the soil itself being of such a loose texture that water readily percolates through it. On the other hand, the sandy clay subsoil is capable of retaining a considerable supply of water during extended periods of dry weather, with the result that crops withstand droughts very well.

Like the other Norfolk soils, the Norfolk fine sandy loam is derived from the sands and clays of the Lafayette formation. The land was originally covered with a forest of longleaf and shortleaf pine, blackjack oak, and white oak, but most of the timber has been removed, and at present practically all of this soil is under cultivation. Although the texture is too light for the best results in general farming, it is well suited to a wide range of agricultural products, and especially to truck crops.

At the present time cotton and corn are the only crops grown to any extent. Cotton yields from one-fourth to one-third bale and corn from 10 to 12 bushels per acre.

The Norfolk fine sandy loam, with a depth of from 10 to 20 inches to the subsoil, is the land on which the best Sumatra cigar tobacco is produced in Florida and Georgia.

The following table gives the results of mechanical analyses of the soil and subsoil of the Norfolk fine sandy loam:

Mechanical analyses of Norfolk fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18787	Soil	2.0	8.7	8.0	25.5	22.8	25.1	7.6
18788	Subsoil	.8	12.1	12.4	23.9	19.3	15.8	15.4

NORFOLK SAND.

The surface soil of the Norfolk sand consists of a gray or light-brown sand from 10 to 15 inches in depth. The sand is composed mainly of medium to fine rounded quartz grains, with frequently a small percentage of coarse, angular grains. The soil contains a relative high percentage of organic matter, which, together with considerable fine material, makes it somewhat loamy in texture. For

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this reason, taken as a whole, it is more loamy and productive than the typical soil as mapped in other areas.

Nowhere in the county is the type found in any extensive areas having a loose, incoherent, sandy soil. Occasionally a sprinkling of quartz pebbles, the size of a pea or larger, is found. This condition is not general and is usually found along some of the slopes adjacent to small streams. This gravelly phase is shown on the map by means of the gravel symbol.

The subsoil consists of a yellowish or light-gray sand of a texture similar to the soil, though with a more open structure. Varying quantities of coarse, angular quartz grains also occur in the subsoil.

The Norfolk sand covers about 35.3 per cent of the county and is the most widely distributed of the soils. The surface features vary from rolling to undulating, the areas occupying hills, ridges, slopes, and narrow valleys. It is a thoroughly drained soil. Its comparatively porous texture causes it to dry out in early spring, and the high content of organic matter, together with the relatively high percentage of fine material, makes it a warm, early soil. In some places excessive drainage often causes crops to suffer from drought. This is particularly the case where the soil is deepest and leaching of the organic matter has taken place. Sedimentary in origin, the Norfolk sand has been derived through weathering from the Lafayette mantle. Some areas have been reworked more or less by water and wind action.

The largest areas occur along Abbie Creek and its tributaries, in the eastern part of the county. Other areas along the Choctawhatchee River, Poor Creek, and the bluff of the Chattahoochee River are of considerable size. Areas of less extent occur generously distributed throughout the county.

At present much of the Norfolk sand area is covered with a growth of longleaf and shortleaf pine, oak, sweet gum, and hickory.

The Norfolk sand is naturally adapted to truck growing. Peas, beans, radishes, lettuce, collards, sweet potatoes, cantaloupes, watermelons, strawberries, etc., do exceptionally well. However, as the local market for truck is limited and the growing of such products for distant markets is but little developed, most of this soil at present under cultivation is devoted to general farming.

Cotton, corn, oats, peanuts, cowpeas, and sweet potatoes are the chief crops, with fairly good yields in favorable seasons. Corn yields from 8 to 12 bushels, cotton about one-third bale, and oats 12 to 18 bushels per acre. Bermuda and crab grass give good pasturage, and in some cases are cut for hay. New ground of this soil produces somewhat better yields than those stated. After the first three years, unless properly cared for and the content of organic matter maintained, the yields decrease rapidly.

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In order to increase or even to maintain the productiveness of this soil the growing of legumes or other green manuring crops is necessary and should be more extensively practiced. To this end the annual growth of grass and weeds should not be burned off, but wherever practicable should be turned under and allowed to decay in the soil.

The Norfolk sand sells from $5 to $12 an acre, according to location and the state of improvements.

The following table gives the average results of mechanical analyses of samples of this type of soil:

Mechanical analyses of Norfolk sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18791, 18793	Soil	3.4	20.0	24.5	36.9	5.1	7.2	2.8
18792, 18794	Subsoil	2.9	18.2	24.4	38.6	4.6	8.3	2.9

CAHABA CLAY

The Cahaba clay consists of 1 to 4 inches of grayish-brown silty fine sandy loam, underlain to a depth of 36 inches by a stiff red or reddish-brown clay, sometimes slightly streaked and mottled with yellow. Below 36 inches the subsoil becomes lighter in texture, owing to increasing amounts of very fine sand. The subsoil has a peculiar greasy feel, the result of small mica flakes which are present in large quantities. Considerable areas in this type have the clay subsoil exposed at the surface, and in fact little of the type has as much as 4 inches of soil. In poorly drained depressions the surface soil is darker and decidedly silty.

The Cahaba clay is found entirely on the second bottoms of the Chattahoochee River. It is the most important river-bottom type in the county, as it occupies at least three-fourths of the bottom-land area. The largest bodies are found in the vicinity of and a few miles south of Franklin, where occur areas 2 or 3 square miles in extent. The surface is usually level to undulating, with sufficient slope to insure good drainage.

Alluvial in origin, the Cahaba clay occupies the larger part of the second terraces of the Chattahoochee River. It lies from 30 to 40 feet above the low-water mark of that stream, and is subject to overflow not more than once in ten or fifteen years. The clay subsoil was probably brought down from the Piedmont Plateau and deposited in deep, quiet water during a period of submergence. The soil is of later origin, being derived in part from the adjacent uplands.

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This soil was originally covered with a growth of shortleaf pine, gum, and oak, but this has been removed, and at the present time practically all of the area is under cultivation.

Owing to its stiff, plastic nature and tendency to bake it is a difficult soil to till, but when properly handled it is the best of the river-bottom soils, and one of the most productive soils in the county. Oats and hay do better than on any other soil. Cotton, with but little fertilization and indifferent cultivation, produces one-half bale per acre. With very little extra expense and effort it would produce 1 bale per acre. Corn gives 15 to 20 bushels per acre under similar treatment, and the yields could easily be doubled.

While the Cahaba clay is more productive than the sandier soils, still it suffers more severely from drought. Possessing naturally a higher moisture content than the sandier soils, its liability to drought must be traced to the shallow plowing and insufficient cultivation. In the majority of cases the soil is not broken deeper than 2 to 4 inches, thus barely reaching through the surface sandy layer. If the land were plowed deeper, permitting the plants to develop a better root system, it would probably withstand the drought better than the sandier soils.

In value the Cahaba clay is somewhat higher than the other river-bottom soils, the prices ranging from $20 to $25 an acre.

The results of mechanical analyses of samples of this type of soil are given in the following table:

Mechanical analyses of Cahaba clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18773	Soil	0.4	1.0	1.1	21.9	30.8	36.2	8.2
18774	Subsoil	.2	1.6	1.3	14.2	11.3	37.8	33.4

CAHABA FINE SAND.

The Cahaba fine sand consists of 10 to 12 inches of grayish-brown loamy fine sand, underlain by a reddish-brown or, in some cases, a dull-red loamy fine sand reaching to a depth of 36 inches or more. Below this and somewhere between 36 and 40 inches is a layer of stiff reddish-brown clay, having that greasy feel so peculiar to the Susquehanna soils. Small mica flakes are found in both soil and subsoil, but are much more abundant in the latter. Being of a loose, porous nature and well drained, this type is easily cultivated.

The Cahaba fine sand is confined entirely to the second bottoms of the Chattahoochee River, where it usually occurs as long, narrow sand

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ridges in larger bodies of Cahaba sandy loam or Cahaba clay. The largest bodies occur in the vicinity of Franklin.

As a whole, the soil is comparatively level, but on account of the loose, porous nature of both soil and subsoil the type retains moisture poorly, and as a result crops do not withstand periods of dry weather as well as on the other river soils.

The Cahaba fine sand probably owes its origin to water action, which resulted in the formation of the second bottom terraces during the Pleistocene period.

At the present time practically all of this soil is cleared and under cultivation. It was formerly covered with a growth of shortleaf pine, oak, sweet gum, and poplar. It is utilized chiefly in growing peanuts, to which it seems to be admirably suited. The crop is not harvested, but in the fall the pigs are turned on the land and allowed to gather the peanuts for themselves. Cotton, corn, and oats are grown to a very limited extent, but the yields are rather light. Cotton yields one-fourth bale per acre and corn 7 to 8 bushels. As the oat crop is not thrashed, no definite figures can be given.

The fertilizer application, as with all other soils of the area, is from 200 to 300 pounds per acre.

This soil is especially in need of organic matter and would be greatly benefited by the application of barnyard manure or by the use of more leguminous crops as a green manure.

The following table gives the average results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Cahaba fine sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18767, 18769	Soil	0.5	4.2	8.4	57.4	16.4	8.5	3.9
18768, 18770	Subsoil	.5	3.6	9.4	57.5	15.2	7.6	5.9

CAHABA SANDY LOAM.

The soil of the Cahaba sandy loam, to a depth of 12 inches, consists of a medium to fine, reddish-brown loamy sand or sandy loam, with a high percentage of fine sand. The surface, when dry, has a grayish appearance. The subsoil, from 12 to 36 inches, is a stiff heavy clay, reddish brown in color when wet, but becoming a yellowish red when dry. Below 36 inches this clay becomes somewhat sandier and less compact. Many small mica flakes are found in both soil and subsoil.

Like the sand, the Cahaba sandy loam is found only in the second bottoms of the Chattahoochee River. Next to the Cahaba clay it is

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the most important agricultural type in the river bottoms. It occupies a position intermediate between the Cahaba clay and the Cahaba fine sand, being a few feet higher than the clay and a little lower than the ridges of sand. Its surface as a rule is nearly level, but generally has sufficient slope to be well drained.

Because of the rather loose condition of the soil and its good drainage conditions the type is very easily cultivated. This type was laid down in water during the formation of the second-bottom terraces, which, as stated, were probably formed during the Pleistocene period. The clay subsoil, as is indicated by the color and the large quantities of mica present, was derived chiefly from the Piedmont, while the sandy surface soil is thought to be of later formation and is in part, at least, derived from the near-by upland soils.

The native vegetation consisted of shortleaf pine, gum, and oak, but at the present time practically every acre of this type is cleared and under cultivation. Cotton, corn, oats, and peanuts are the principal crops. Cotton yields about one-third bale per acre, and corn 10 to 12 bushels. Very fair yields of oats are secured, but as they are not thrashed no definite figures can be given.

Undoubtedly the yields could be greatly increased if the land were plowed deeper and organic matter, either in the form of barnyard manure or in the form of green manure, were applied to the fields. This soil should produce an excellent grade of Cuban cigar filler tobacco.

This is a very good soil for general farm purposes, but it has been more or less neglected, as it has been left almost entirely to the care of negro tenants. The value of land of this character ranges from $15 to $25 an acre.

The following table gives the results of mechanical analyses of typical samples of soil and subsoil of this type:

Mechanical analyses of Cahaba sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18771	Soil	0.3	4.1	21.1	41.0	6.6	16.7	10.0
18772	Subsoil	.3	2.4	7.1	16.9	5.5	31.5	36.4

GREENVILLE SANDY LOAM.

The soil of the Greenville sandy loam consists of a reddish-brown medium sandy loam about 12 inches deep. The subsoil is a brick-red sticky sand to sandy loam, becoming heavier with depth. Both soil and subsoil contain some coarse sand.

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The type is found principally in the southern part of the county, where it is typically developed in the areas northwest of Headland. It occupies level to gently rolling country, and on account of its open texture is a well-drained soil. The subsoil is capable of retaining a relatively large quantity of moisture, which fact, coupled with the light, mellow surface soil, makes this a desirable type both for the staple and special crops.

A moderately rolling shallow or heavy phase is encountered in the southeastern part of the county, which consists of a dark-red or reddish-brown rather heavy sandy loam underlain at a depth of about 6 inches by a stiff, bright-red sandy clay. On some of the steeper slopes the sandy loam covering has been washed away, leaving small patches of clay exposed. When wet this phase is very sticky and it hardens on drying, thus making it more difficult to cultivate than the deeper, lighter phase.

The Greenville sandy loam is closely related to the Orangeburg soils. It has been derived from the materials of the Lafayette formation in the same manner as the Orangeburg soils. The surface soil resembles some phases of the Orangeburg sandy loam, but is always more nearly red in color. In texture the subsoil is somewhat like the subsoil of the Norfolk soils, but in color it closely resembles the subsoil of the Orangeburg sand.

Like the rest of the soils of the county, the Greenville sandy loam is farmed to cotton, corn, and peanuts. Most of the type has been cleared of the original forest of pine and hardwoods and is now under cultivation.

With light applications of fertilizer, the light phase produces from one-third to one-half bale of cotton and from 12 to 25 bushels of corn per acre.

When properly tilled the heavy phase of this type is the most productive of the upland soils, being considered excellent for general farming purposes. It is well adapted to the production of hay, oats, and nearly all other farm crops and is also an excellent peach soil. At present cotton and corn are the only crops grown to any extent. Under the methods in vogue, cotton produces one-half bale and corn 15 to 20 bushels per acre, but this phase of the type can easily be made to yield much larger returns. It has been shown that, with very little extra labor and expense, one bale of cotton per acre can be produced.

Since the stiff clay subsoil of this phase is near the surface, plowing is usually shallower than on the sandier soils, while it is much more essential that soil of this character be plowed deep. By breaking the land to a greater depth erosion will be lessened, while at the same time the water-holding capacity of the soil will be increased and the plants will be enabled to develop a more extensive root system, so that

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they will suffer less from drought. If also some system of rotation be adopted that will add humus to the soil, the yields will be greatly improved.

The heavy phase of this type ranges in value from $20 to $25 an acre. The lighter phase can be bought at a lower price.

The following table gives the average results of mechanical analyses of samples of this type of soil:

Mechanical analyses of Greenville sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
Shallow phase:		*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18775, 18777...	Soil.....	1.7	14.5	15.6	27.2	8.8	18.2	13.7
18776, 18778...	Subsoil.....	.7	10.6	10.6	21.8	6.9	13.1	35.9
Light phase:								
18779, 18781...	Soil.....	1.9	19.1	18.1	32.9	8.8	10.4	8.7
18780, 18782...	Subsoil.....	1.7	18.7	15.6	28.1	8.1	10.1	17.4

PORTSMOUTH SANDY LOAM.

The soil of the Portsmouth sandy loam ranges from a grayish medium sand to a black mucky soil. The depth of the surface material varies greatly, but averages 12 inches. Below this depth is a gray, sandy clay streaked and mottled with yellow, which is underlain at 36 to 40 inches by a lighter colored, stiff, compact, sandy clay.

Soil of this character is confined chiefly to the southeastern part of the county, in small, poorly drained areas situated at the heads of small streams. The largest bodies are found a few miles south of Franklin, at the base of the bluff that marks the line of separation between the second bottoms of the Chattahoochee and the adjacent uplands. In wet seasons many small branches heading in the bluff pour their waters into this depression and keep it submerged, but in a dry season the higher portions can be cultivated.

The Portsmouth sandy loam is of sedimentary origin, having been formed from the sands and clays of the Lafayette formation, but its original texture has undergone some changes by the accumulation of large quantities of organic matter.

The topography is level, and as the areas are usually lower lying than the bordering soils they are as a rule poorly drained. When artificially drained the areas are moderately productive, owing mainly to the abundance of organic matter, while on account of the loose porous nature of the soil cultivation is easy.

The native growth consists principally of longleaf and shortleaf pine, black gum, and gallberry bushes.

Only a few of the small and better drained portions of this type are under cultivation. On these the yields are usually light, ranging

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from one-fourth to one-third bale of cotton and from 8 to 10 bushels of corn per acre. The area of this soil is limited and it is of little agricultural importance.

The results of mechanical analyses of soil and subsoil are given in the following table:

Mechanical analyses of Portsmouth sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18811	Soil	2.3	18.1	14.3	33.1	12.5	11.8	7.5
18812	Subsoil	3.3	19.3	10.0	32.0	12.5	12.6	10.5

SUSQUEHANNA CLAY.

The soil of the Susquehanna clay consists of a gray fine sand or silty sand having an average depth of 4 to 5 inches. The subsoil is a heavy red clay, very impervious, and having a peculiar greasy feel, the result of finely divided mica flakes. The subsoil may be mottled with gray immediately below the surface or it may grade into a mottled red and gray clay at a depth of 28 to 36 inches. In nearly every case the percentage of gray matter increases with depth, until it finally becomes the predominating color.

This type, as mapped, also includes a few small and nearly level areas where the depth of the sandy surface material is 8 to 10 inches deep, but these areas are so limited in extent that they were not mapped as a separate type.

The Susquehanna clay is stiff and plastic when wet and hardens on drying, making it a difficult soil to cultivate.

Only two bodies of any consequence have been mapped, and both of these are in the eastern part of the county, just west and north of Franklin. In the northern and rougher portions of the county, where the streams have worn deep valleys, narrow strips of Susquehanna clay are found at the base of the slopes and bordering the streams. These areas, however, were as a rule too small to be mapped.

The greater proportion of the Susquehanna clay occurs as very steep or broken areas, from which a large part of the surface soil has been eroded. Owing to its rolling and sloping topography, the surface drainage is excellent, and in fact often excessive and rapid, as is evidenced by the eroded condition of the steeper slopes.

Susquehanna clay has been derived from the sedimentary deposits of a transition period between the underlying Cretaceous limestone and the clays and sands of the next later formation which gives rise to the Norfolk and Orangeburg soils.

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Uncultivated areas of this type are covered with a heavy growth of longleaf pine, black-jack, and white oak. Owing to its generally rough and broken nature little of the soil is under cultivation, and only the small and more level sandy areas are used. The only crops grown to any extent are cotton and corn. The yields of the former are one-fourth to one-half bale per acre and of the latter from 8 to 12 bushels.

The average results of mechanical analyses of typical samples of soil and subsoil are given in the following table:

Mechanical analyses of Susquehanna clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18813, 18815	Soil	0.5	5.4	5.5	39.2	21.0	20.9	7.1
18814, 18816	Subsoil	.2	1.2	1.1	5.7	9.7	36.2	45.9

OCKLOCKNEE LOAM.

The surface soil of the Ocklocknee loam consists of a fine, mellow, dark-colored fine loam or sandy loam, varying from 8 to 15 inches in depth. The subsoil consists of a drab, yellow, or brown mottled heavy sandy loam or clay loam, which extends to a depth of 3 feet or more. Sometimes the heavy subsoil is lacking, and the subsoil is then a gray, iron-stained sand or light sandy loam.

Owing to its flat surface and low-lying position, the Ocklocknee loam is naturally poorly drained. In wet seasons it is submerged or rendered unfit to cultivate for some time. It is thus a cold, late soil, and crops can not be planted as early as upon the upland types.

This soil is alluvial in origin, the material composing it being made up of the finer particles washed from the upland soils.

The areas have been subjected to more or less swampy conditions, and the soil has incorporated within it a high percentage of organic matter. In color, position, and texture the surface soil of the Ocklocknee loam closely resembles the Swamp areas which it always borders.

Land of this type of soil is very limited in extent, there being but 640 acres in the county. The largest body—cleared in 1908—is found at the junction of Sandy and Abbie creeks. Small areas occur along the Choctawhatchee River.

The greater part of the soil is under cultivation. It is recognized as a strong soil and one that does not require commercial fertilizers. In favorable seasons good yields of corn and cotton are produced. Sugar cane does exceptionally well upon this low-lying soil.

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The original forest growth consists of pine, magnolia, bay, gum, and beech.

The results of mechanical analyses of a sample of the soil and subsoil of the Ocklocknee loam are given in the following table:

Mechanical analyses of Ocklocknee loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18797	Soil	0.6	3.2	3.2	43.9	20.8	20.4	7.6
18798	Subsoil	.4	6.3	5.4	43.3	11.5	17.5	15.6

SWAMP.

The Swamp embraces those soils which have such poor natural drainage that they are covered with water most of the year and unfit for cultivation. The soil is of variable texture. For the most part it is a heavy dark or brown loam or clay loam of variable depth, underlain by a drab or brown iron-stained clay.

The Swamp areas occur as narrow, low-lying strips of land adjoining stream channels. A few small areas and elongated strips occur in the Cahaba clay near Franklin and elsewhere in the southern part of the county. There is no Swamp along the immediate course of the Chattahoochee River.

The most extensive areas occur along the shallow Choctawhatchee River and Abbie Creek. Where Cowpens and Indian creeks empty into the river the swamp area is over 1 mile in width. The surface is flat except where "cut-offs" or channels, through which water flows only in times of floods, have dissected it. These small depressions, in which water remains much of the time, are locally known as "lakes."

The smallest streams, starting from a spring or seepage, have strips of Swamp from the sources along the entire length of their shallow ill-defined channels.

The Swamp areas would undoubtedly prove very desirable land for grass and corn if properly diked and drained. This would involve considerable expense and no one has yet seen fit to make the attempt.

Small cultivated areas occupying a slightly higher position have been mapped as Ocklocknee loam.

The Swamp areas are heavily forested with pine, bay, magnolia, beech, water oak, ash, and a few scattering cypress. Cane, briers, and vines form an almost impenetrable mass bordering many of the streams.

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SUMMARY.

Henry County is located in the southeast corner of the State of Alabama, about 125 miles east of Montgomery. It has an area of 570 square miles. The northern part of the county is rolling to hilly; the southern part is gently rolling, with large bodies of nearly level land. The elevation of the former section is about 500 feet or more, and of the latter, 409 feet and less.

Henry County was organized in 1819. The first settlers came from Georgia and South Carolina in 1817. The population of the county is estimated to be from 16,000 to 20,000. The central and southern parts of the county are the more thickly settled.

The principal crop is cotton. It is often grown to the exclusion of the subsistence crops. Corn is grown for home use and local demand, but the production is not sufficient. Oats, sugar cane, sweet potatoes, and peanuts are minor crops.

The growing of cantaloupes and watermelons for local and northern markets, while only in the first stages of development, has given promise of great success. Trucking could be profitably extended to include crops other than those grown at present. This industry so far is confined to Headland and vicinity and to a few small areas near the Central of Georgia Railroad, in the southeast corner of the county.

The rotation of crops is little practiced because of the large acreage of cotton, and not sufficient attention is paid to crop adaptation or to methods of cultivation.

The average size of the farms is about 160 acres. From 20 to 50 per cent of the farms are operated by the owners. The value of farm land ranges from $5 an acre for the most remote areas of sandy land to $50 or $75 for the best type of soil in most favorable locations. The price of land has increased greatly within the last few years.

The soils of Henry County vary from a sand to a clay. This is true of both the upland and the Chattahoochee River bottom soils.

The upland, which comprises nearly all of the county, is occupied by two main soil series—the Norfolk and the Orangeburg. The Norfolk soils have yellow subsoils and the Orangeburg red. Both are of large extent.

Fifteen soil types, including Swamp, were recognized and mapped. All these soils, except Swamp, are used to some extent for general farming.

Sandy loams predominate, there being eight in all; seven are found in the uplands and one is a river-bottom type. These sandy loams constitute the best general-purpose soils of the county. All the crops grown in the county are produced upon these soils, the yields depending upon the cultural methods and fertilization.

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Cotton when grown upon soils having a red sandy clay subsoil is less susceptible to the wilt disease.

There are three sand types; two belong to the uplands and one to the bottom lands. These sands are the least productive of all the soils. Crops suffer in droughty seasons. When near markets they should be devoted to trucking.

The Ocklocknee loam occurs in limited areas principally along the Choctawhatchee River. It is a low-lying soil particularly adapted to corn.

Two clay types, one in the uplands and the other a bottom type, were mapped.

The Susquehanna clay, the upland type, is the heaviest soil of the county. The surface generally is broken, and practically none of the type is under cultivation. It is difficult to cultivate, but when properly handled makes a strong grain and grass soil.

The Cahaba clay is a very desirable strong soil, and most of the type is under cultivation. Alfalfa would prove a profitable crop.

The Swamp lands are not cultivated. They afford some pasturage and in some places a valuable timber growth.

More attention should be given to the permanent upbuilding of the soils. Crop rotation should be practiced and more leguminous crops should be grown. The average depth of plowing should be increased on all the soils, except perhaps the sands.

More live stock should be kept and more improved labor-saving farm machinery could be advantageously used.

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SOIL SURVEY OF AUTAUGA COUNTY ALABAMA.

By L. A. HURST, of the U. S. Department of Agriculture, and C. S. WALDROP, of the Alabama Department of Agriculture and Industries.

DESCRIPTION OF THE AREA.

Autauga County, Ala., is located near the geographic center of the State, and is included within meridians 86° 24′ and 87° 55′ west of Greenwich and parallels 32° 18′ and 32° 46′ north latitude. It is bounded on the north by Chilton County and on the east by Elmore County, while on the south and west the Alabama River and Big Mulberry Creek form an irregular boundary, separating it from Montgomery, Lowndes, and Dallas counties. Autauga County was originally a part of Montgomery County, from which it was separated in 1818. Later its area was reduced in the formation of other counties. The present area of the county is about 380,800 acres, or 595 square miles. The base map, scale 1 inch to the mile, upon which are located the towns, roads, railroads, streams, branches, houses, churches, and schoolhouses, was constructed with the plane table as the soil mapping progressed.

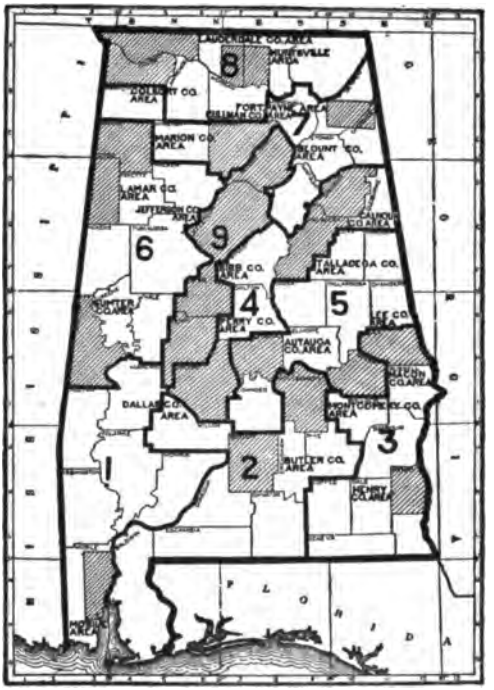

FIG. 12.—Sketch map showing location of the Autauga County area, Alabama.

The physiographic features of Autauga County embrace the comparatively level plains along the Alabama River and its larger tributaries and the hilly upland bordering these plains. This upland increases in ruggedness toward the northern part of the county, the elevation ranging from 250 to 650 feet above sea. Comparatively level peneplains or plateaus occur throughout the uplands, the

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largest ones being located in the vicinity of Prattville, Autaugaville, and Mulberry. The uplands in the vicinity of stream courses are usually characterized by sharp ridges and steep escarpments.

The drainage of the uplands is usually excessive, and where steeper slopes are left unprotected serious erosion often takes place, resulting in the formation of steep, precipitous gullies. The bottom lands along the rivers are not naturally as well drained and frequently have to be supplied with artificial drainage.

Big Mulberry, Little Mulberry, Autauga, Swift, Beaver, Indian, and Buck creeks, all of which have a general southerly direction and whose waters flow into the Alabama River, form the main drainage system of the county. A small portion of the northeastern part of the area is drained by Mortar Creek.

The larger streams, including Big Mulberry, Little Mulberry, Autauga, Swift, and Buck creeks, are swift-running streams and are being developed to some extent for water power for lighting and manufacturing purposes.

The early inhabitants of Autauga County came from the Carolinas, Georgia, Virginia, and the New England States. The first community settlement was made in "Dutch Bend" in 1820 by immigrants of German descent who came from South Carolina. As early as 1818 a store was erected at Thompson's Bluff, a few miles up the river from Old Washington. The latter place was established as the seat of justice in 1825, but in 1833 the court-house was moved to Old Kingston. In 1868 the county seat was again moved to its present location at Prattville. Prattville has a population of about 2,000 and is the social and commercial center of the county. The other important towns and post-offices of the county are Billingsley, Marbury, Wadsworth, Booth, Vida, Haynes, Jones, Spur, Fremont, Mulberry, Independence, Huckabee, Autaugaville, and Kingston.

The county became somewhat noted for its manufacturing as early as 1833, when a cotton-gin factory of considerable capacity was established by Daniel Pratt. In 1846 a cotton mill was built at Prattville, and at about the same time another was established at Autaugaville. The industries now in operation include the gin factory, cotton mill, and cotton-seed oil mill at Prattville, and a number of large sawmills, located at Autaugaville, Marbury, Vida, Spur, and Jones. There are also in the county several small potteries, two turpentine stills, and four cigar factories. Many portable sawmills are at work in different parts of the county.

The first means of transportation to market was by "pole boat" down the Alabama River to Mobile. Later this was succeeded by steamboats, which plied between Montgomery and Mobile. This was practically the only means of reaching outside markets until the advent of railroads.

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Four railroads now reach the county. The main line of the Louisville and Nashville, from Montgomery to Birmingham, crosses the northeastern corner of the county. The Mobile and Ohio Railroad, from Montgomery to St. Louis, crosses the eastern half of the county, entering near the southeastern corner and leaving the area near the center of the northern boundary. The Alabama Central connects Autaugaville with Booth. The Southern Railway from Rome, Ga., to Meridian, Miss., runs down the western edge of the county in the valley of Big Mulberry Creek. A branch of the Louisville and Nashville Railroad to Prattville furnishes additional transportation facilities to Montgomery, the principal market. Mobile has always been the chief seaport market. Most of the fruits and vegetables are shipped to Montgomery or Birmingham, or to more distant northern markets.

The southern half of Autauga County lies within the artesian belt, and a large number of flowing wells furnish an abundance of good water for domestic and manufacturing purposes. The water supply for the remainder of the county is usually obtained from springs and dug wells, ranging in depth from 30 to 80 or more feet.

The public roads of the county have been considerably improved during the last few years, but much still remains to be done in this direction.

CLIMATE.

No very complete record of the weather conditions in Autauga County being available, data has been taken from the station at Montgomery in the adjoining county. An examination of the accompanying table shows that the winters are of short duration, with little or no zero weather, and a monthly mean temperature considerably above the freezing point. The lowest temperatures are usually accompanied by north winds, which sometimes freeze the ground to the depth of an inch or so, and occasionally there is a slight snowfall, but this is soon melted. The summers are long and sometimes hot, but the mean temperature for June, July, and August, the three hottest months, is about 80° F. The Gulf winds modify somewhat the temperatures of the summer months, and the nights are generally cool.

The average mean annual precipitation, based on the records of twenty-five years, has been about 51 inches, while the mean monthly average ranges from 2.7 inches in September to 6.3 inches in March. The rainfall is sufficient to insure maximum yields of all crops suited to the region if ordinary attention is given to the tillage of the soil to conserve the moisture.

The maximum precipitation occurs during the winter months, when serious damage often results from washing and gullying unless the fields are protected by terraces, sidehill ditches, or the growing of

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winter cover crops. The minimum precipitation usually occurs in the late summer or fall months, which makes it all the more favorable for the maturing and gathering of corn and cotton.

With regard to frost, the records at Montgomery give the date of the last killing frost in the spring as March 11, and that for the first in the fall as November 8. There is thus a period of nearly eight months during which tenderest vegetation will grow, and some crops may be grown throughout the year.

The mild winter makes it possible to graze stock and do outdoor work practically all the year. Shelter should, however, be provided for stock at night during the winter season.

The county in general is healthful and is supplied with an abundance of good water, a large portion of which comes from flowing wells ranging from 50 to 200 feet in depth.

The following table, compiled from the records at Montgomery, gives a general idea of the climatic conditions in this part of the State:

Normal monthly and annual temperature and precipitation, etc., for Montgomery.

Month.	Temperature.			Precipitation.			
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year.	Total amount for the wettest year.	Snow, average depth.
	°F.	°F.	°F.	In.	In.	In.	In.
January	48	79	5	5.0	7.2	17.8	0.4
February	51	83	−5	5.0	2.0	3.0	.8
March	58	87	21	6.3	3.6	11.9	Trace.
April	65	92	30	4.5	8.2	1.1	.0
May	74	98	43	3.8	2.6	2.6	.0
June	80	106	48	4.3	5.0	3.8	.0
July	82	107	61	4.6	.9	9.6	.0
August	81	103	58	4.6	2.1	7.8	.0
September	76	99	45	2.7	.2	2.7	.0
October	66	96	31	2.3	2.0	.4	.0
November	56	85	21	3.2	1.7	4.4	.0
December	49	79	8	4.5	4.2	4.7	.5
Year	66	107	−5	50.8	39.7	69.8	1.7

AGRICULTURE.

Beginning with the settlement of Autauga County, about 1818, its agricultural development has been centered upon the two staple crops, cotton and corn. Prior to the settlement of the county the lands were occupied by the Creek Indians, who used the region as their hunting grounds, and also grew a few small patches of maize.

The only means of transportation available to the early settlers was the "pole boat" on the Alabama River, and the pack mule. They

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were obliged, therefore, to raise at home most of what was consumed. The cotton which they grew was woven into homespun; most of the wheat and a part of the corn was ground into flour and meal. They also grew rye, oats, and hay, and produced what pork, beef, and mutton they needed. Some tobacco was also grown for home use.

The immigrants of German descent who came from South Carolina were largely responsible for the early agricultural development of the area. They settled in one of the larger bends of the Alabama River, which was afterwards named "Dutch Bend." They were industrious, and it was not long before they developed a rich agricultural community and attracted immigrants from various other States, east and north, who also settled in the southern part of the county. Many of these early settlers accumulated considerable wealth in antebellum days. After the war conditions were changed, the large plantations with their organized labor were broken up, the lands thrown out of cultivation or farmed under the tenant system, which has persisted until this day. As the negro tenants are better qualified to grow cotton than the other crops, the farming has drifted into a one-crop system.

Cotton is grown upon the same land year after year, with the result the soils have lost much of their organic matter, while changes in their physical condition have helped to decrease the yields. To supply the deficiency commercial fertilizers of various kinds are used. Over $30,000 annually is expended in this way in Autauga County. In the last few years the "one-crop" system has been displaced to some extent by various crop rotations, whereby the fertility in the soil is restored through natural rather than artificial sources. The rotation usually practieed is made to include as many crops of cotton as possible and still maintain an average yield. The planting of cowpeas or peanuts between the corn rows has come into practice. Some follow the corn and pea crop with oats, or vetch and rye, which, besides preventing the land from washing, affords excellent winter pasturage. One of the best rotations is that recommended by the Auburn, Ala., experiment station. It consists of pease sown between the rows of corn, followed by oats in the fall. Second year follow oats with soy beans, cowpeas, or peanuts; third year, follow cotton with crimson clover or vetch and rye; fourth year, again follow cotton with oats, clover, or rye and vetch.

Some good system of rotation is always desirable, but for those who feel that they must grow cotton year after year on the same land the following method of green manuring is recommended: Plant cotton in rows 5 feet apart and at the last cultivation of the crop sow vetch broadcast. The following spring plant cotton in the middles of the old rows made up into beds as usual, leaving a narrow

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strip upon which are standing last year's stalks and enough vetch to seed the ground for next year. After the vetch has gone to seed cut down the old cotton stalks, plow out the ridge upon which they stood, and sow cowpeas in the depression. In the fall the vetch is allowed to come up again, while the cowpeas are left to decay. Cotton follows cowpeas, while vetch is allowed to seed on the old cotton bed. Vetch produces a better stand usually upon soils which have previously been sown in cowpeas. A stand is not always obtained the first year, in which case the land should be reseeded the following year.

The present methods of tilling the soil, especially in the case of tenants, differ from those practiced in the earlier days. The plowing is usually done with the one-horse breaking plows, and the soil is seldom turned to a depth of more than 3 or 4 inches. The more progressive farmers are, however, using modern machinery for plowing their fields deeper and practicing more shallow after cultivation. This insures better drainage, better aeration, and a deeper feeding zone for the growing crops.

According to the census of 1900 the number of acres planted to cotton in 1899 was 50,000, or an area one-third greater than the combined acreage of all other crops and more than double that of corn. From this acreage an average yield of one-third bale per acre was secured. The greater part of the cotton is grown in the southern half of the county, where the soils are better adapted to its production. In the northern part of the county the soils are more sandy or gravelly, and this section has not been extensively developed. It is unlikely that cotton will ever become an important crop in this section of the county.

In 1889 the acreage in corn was between 25,000 and 30,000 acres. The average yield per acre was low, being only 10 bushels. Corn is by far the most important of the grain crops. Oats is next in importance, but only 3,000 acres is returned by the census as in this crop. Cowpeas and peanuts form important items in the agriculture of the county. In 1889 there were produced 25,000 bushels of cowpeas and 30,000 bushels of peanuts. This is of course aside from the acreage devoted to cowpeas grown for hay, which probably exceeds the area devoted to the production of seed.

The planting of pecan trees has attracted much attention in the last few years, and several large orchards have been planted in the vicinity of the Alabama River and in a few cases upon the uplands. Although but few of the orchards are in bearing, the growing of pecans bids fair to become an important industry in the county.

Trucking is being carried on in the vicinity of Prattville, the most important products being cabbage, tomatoes, peas, beans, and potatoes. The greater part of the truck grown is consumed in the county or sold

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in Montgomery. Large areas of soils exist in Autauga County which are suitable to the growing of all kinds of truck crops, including potatoes, tomatoes, watermelons, and cantaloupes; so that this industry might be greatly extended. According to the census of 1900, about 1,000 acres were devoted to sweet and Irish potatoes, with an average yield of 75 bushels per acre. The same authority gives the total value of miscellaneous vegetables produced in the county as $42,945. Sugar cane and sorghum are grown to considerable extent and molasses and sirup of excellent quality are produced, but very little is marketed outside of the county. The census gives the production as 30,000 gallons of sirup annually and the yield per acre as 146 gallons. Stock raising has received but little attention in this area in the past, but with the introduction of more intensified methods of farming this industry is gradually being extended.

Fruit growing is another industry that might be developed in some sections, especially on the sandy and gravelly soils of the northern part of the county. Until recently this section has been forested with a heavy growth of longleaf pine, but this is rapidly being removed by numerous sawmills. Peaches of excellent quality are grown at present in the county, but no large shipments are made. Grapes, plums, and apples do well upon the Guin gravelly sandy loam, but have never been grown upon a large scale.

In the county as a whole the question of the adaptation of certain soils for certain crops has received little thought. Cotton and corn are planted on nearly all the soils, with varying results. Some progressive farmers, truckers, and dairymen, however, are giving the question some attention, as well as trying to improve the yield and quality of their crops by seed selection.

The farm labor is drawn almost entirely from the negro race. As a general rule, the men prefer to work as tenants, and this, taken in connection with the demand for labor by the sawmills and various other enterprises, causes a shortage in the supply of day laborers. Most of the large plantations are parceled out to colored tenants in "one-mule" farms. By this system the tenant is allowed as much land as he can work with one mule, and this is usually about 40 acres. He pays a rental of $2 to $4 an acre or works the crop on shares. In the former case the tenant usually furnishes his own mule, implements, and fertilizer, while in the latter the landlord furnishes practically everything, including half the fertilizer and seed. In both cases the tenants are supplied with cabins and with necessary supplies, giving a lien on the prospective crop as security. In recent years some of the tenants have prospered to such an extent as to enable them to purchase small farms.

Occasionally farm hands are hired by the month, the usual wage ranging from $8 to $12 a month, including board.

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The total area of Autauga County is 595 square miles, of which amount only a little more than half is classed as in farms, and only about one-third of the farm lands are improved. The holdings range in size from a few acres to a thousand or more. Only about one-fourth of the farms are operated by the owners. The value of the farm lands and improvements, according to the census of 1900, including implements and machinery, was $1,571,362. The value of live stock and products not fed to live stock, $1,317,964. This valuation and output has been considerably increased in the last few years.

Deeper plowing and subsoiling are recommended, especially upon "worn-out" soils, and this should be done in conjunction with a complete system of crop rotation, which should include as many crops of legumes as possible. The raising of more stock will naturally follow the planting of forage and winter cover crops and more intensive methods of farm management.

Liberal applications of lime, in conjunction with both stable manure and green manuring crops, is strongly recommended for the farmers of Autauga County.

SOILS.

Autauga County lies within the Coastal Plain region and the different soil types encountered in the survey are similar to those found in various other surveys in the Gulf States. The surface features of the county consist of three natural divisions—namely, the bottoms along the Alabama River and its larger tributaries, the terraces along these same streams, and the uplands. These divisions are distinct from each other, both as to origin and the soils found therein.

The bottom lands represent the most recent formation in the area. They are subject to frequent overflow and are so wet and swampy that, with the exception of the Huntington loam in the bottoms of the Alabama River, they were classified as Meadow and Swamp.

The next division consists of the first and second terraces along the larger streams. The terraces were formed in Pleistocene time and represent depositions which took place either when those streams were estuaries or when the whole region was under the Gulf. The surface features of the terraces are such that the drainage has never been excessive. The terraces are also high enough above the streams to be free from overflow, and for these reasons the material from which the soils are derived have undergone very little change since its original deposition. The main soils found in this division are the Kalmia fine sandy loam, Kalmia sandy loam, Kalmia sand, Myatt sandy loam, Cahaba fine sandy loam, and Cahaba silt loam.

The third division rises rather abruptly from the terrace areas and extends to the northern boundary of the county, being made up principally of level to rolling uplands with good drainage. The soils

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of this division are derived mainly from the gravel, sands, and clays of the Lafayette mantle. In the drainage areas of the creeks and branches, however, these overlying materials have in places been washed off, exposing sands and clays of Cretaceous age which underlie the whole area. In such places these earlier formations enter into the formation of the soil. The soil types found in the uplands are the Orangeburg fine sandy loam, Orangeburg sandy loam, Orangeburg sand, Orangeburg clay, Greenville fine sandy loam, Greenville sandy loam, Norfolk loamy sand, Norfolk sandy loam, Norfolk fine sandy loam, and Guin gravelly sandy loam.

Adjacent to the Alabama River, where erosion has been greater, a narrow strip of the "rotten limestone," one of the subdivisions of the Cretaceous, has been exposed and gives rise to the Houston clay and Houston chalk types.

The following table gives the names and areas of the several soil types shown on the accompanying map:

Areas of different soils.

Soils.	Acres.	Per cent.	Soils.	Acres.	Per cent.
Norfolk loamy sand	76,992	20.2	Greenville fine sandy loam	8,384	2.2
Guin gravelly sandy loam	62,784	16.5	Kalmia fine sandy loam	4,992	1.3
Orangeburg fine sandy loam	51,328	13.5	Myatt sandy loam	4,416	1.2
Orangeburg sandy loam	39,232	10.3	Swamp	3,840	1.0
Orangeburg sand	31,616	8.3	Orangeburg clay	3,712	1.0
Meadow	23,488	6.2	Norfolk fine sandy loam	2,240	.6
Greenville sandy loam	12,032	3.2	Houston chalk	1,728	.4
Kalmia sand	11,904	3.1	Houston clay	1,664	.4
Norfolk sandy loam	10,816	2.8	Huntington loam	1,472	.4
Cahaba fine sandy loam	9,600	2.5	Oktibbeha clay loam	704	.2
Cahaba silt loam	9,152	2.4			
Kalmia sandy loam	8,704	2.3	Total	380,800	.....

ORANGEBURG FINE SANDY LOAM.

The soil of the Orangeburg fine sandy loam consists of a gray or brownish fine sandy loam varying in depth from 6 to 15 inches, but with an average depth of 8 or 9 inches. The subsoil is a red to reddish-yellow sandy clay, which usually reaches its maximum clay content at about 24 to 30 inches, below which the texture becomes coarser and the structure more open and porous.

A large well-developed area of this type occurs in the region west of Swift Creek, while lesser areas are found south and southeast of Mulberry and also northeast of Prattville. Its surface features vary from gently undulating areas upon the broad plateaus to deeply cut and broken areas upon the narrow divides. The topography, together with the rather open character of the subsoil, insures good

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natural drainage; in fact, the drainage is inclined to be excessive in places.

Where this type occurs as rather flat or gently undulating areas upon the plateaus, the soil is usually of a reddish-brown color and shallow. Where it was found practicable to do so these areas were mapped with the Greenville fine sandy loam. Such areas are known locally as "mulatto lands." The removal of the surface soil upon the steeper hillsides gives rise to the Orangeburg clay, but frequently these occur as areas too small to be represented upon the map.

The sandy nature of this type admits generally of easy cultivation, but where the texture is very fine the soil shows some tendency to run together or to become compact during wet seasons. To prevent this the fields should be plowed in the fall and sowed to oats or rye and vetch.

The Orangeburg fine sandy loam is derived through the process of weathering from the sandy clay materials of the Lafayette formation. In its natural state it supported a forest growth of hickory, pine, persimmon, dogwood, and various kinds of oak, including red, black, and post oak.

The main crops grown are cotton and corn, the former being somewhat better adapted to the type than the latter. Cowpeas, velvet beans, oats, and crimson clover also do well. Sugar cane gives large yields, but the color and quality of the sirup do not equal that produced upon the Norfolk soils. The soil is well adapted to peaches, and if properly handled they can be grown with profit. Most of the trees, however, are never sprayed or pruned, and are frequently short lived, and the fruit is diseased and drops off before it is matured. Where the location of orchards is properly selected and the trees cared for according to the best methods, the fruit is of excellent color and size and highly flavored. The Elberta variety is a favorite. There are as yet no large orchards in the county. Figs, plums, and strawberries do well upon this soil, and filler tobacco has been grown with considerable success in Perry, Dallas, and other counties.

A large proportion of this land is worked by colored tenants and is planted year after year to cotton and corn. The first year or two after the land is cleared the humus is sufficient to insure fair yields, but with the usual methods of cultivation of the soil the organic matter is soon depleted and the use of commercial fertilizers is resorted to. No attempt is made permanently to build up the land because the tenant rarely occupies the same farm two years in succession. Where the farms upon this type are managed by the owners and attention is given to crop rotation and deep plowing, yields of one-half to 1 bale of cotton and 15 to 30 bushels of corn per acre have been obtained.

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Experiments which have been conducted upon this soil show that stable manure is superior to mineral fertilizer, and this is even surpassed by green manure (cowpeas) with lime. Stable manure is not always available under the present system of farming, so that the growing of legumes is probably the most practicable method of building up the land. The growing of a winter cover crop to prevent washing and to supply forage should be included in the management of this type as well as of the Orangeburg sandy loam. The native grasses do well and furnish good grazing. With the growing of more forage crops, stock raising could be carried on more extensively. Large bodies of this type are held at $5 to $25 an acre.

The following table gives the mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Orangeburg fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18315	Soil	0.5	1.5	2.4	29.5	21.2	36.2	7.9
18316	Subsoil	.1	1.2	1.5	25.3	13.9	28.4	30.2

ORANGEBURG SANDY LOAM.

The Orangeburg sandy loam, locally known as "gray sandy land," is a grayish to brownish medium-textured sandy loam, ranging in depth from 6 to 15 inches, with an average depth of about 10 inches. The subsoil is a dark-red to brick-red sandy clay to a depth of about 36 inches, below which the clay content diminishes and the material grades into the underlying looser Orange sands.

The greater part of this type occurs between Prattville and Independence. Other areas occur north of Prattville and in the northwestern part of the county.

In topography the Orangeburg sandy loam is characterized by frequent occurrences of deep valleys and tributary gullies, which have dissected the original peneplain into long narrow ridges and steep rounded knolls. Small areas of this table-land occur upon the wider ridges.

The drainage is always excellent and sometimes excessive, so as to cause serious erosion unless the slopes are protected by forest growth or where cultivated by terraces or cover crops. The many gray and red spots upon the hills are due to the exposure of the subsoil caused by erosion. The soil is derived directly from the breaking down of the Lafayette mantle, which forms the main covering over the northern half of the county.

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Forests, chiefly of longleaf and shortleaf pine, originally covered this soil, but these are being rapidly exhausted by the lumber companies. In recent years considerable areas of stump land have been cleared and put under cultivation. For the first few years the yield per acre of cotton without fertilizer varies from one-half to three-fourths bale, while that for corn ranges from 15 to 20 bushels, but with continuous cropping the humus is soon exhausted, and the productiveness of the land declines rapidly. In some cases the yields are maintained by the regular use of commercial fertilizers; in others a reasonable return may be expected from this land each year. As soon as the yields become too small to give a fair profit the fields are abandoned and allowed to grow up in field pine. The use of fertilizers is increased from year to year as the supply of virgin soil becomes less. It is less affected by the extreme weather conditions of drought or excessive rains than some of the other upland types, and being more open and porous than the finer textured Orangeburg fine sandy loam it is less liable to compact or run together and is easier to cultivate. The two soils, however, have about the same agricultural value. It responds readily to the use of fertilizers and is a warmer soil generally than the Norfolk type of the same texture.

The Orangeburg sandy loam is especially well adapted to cotton, and also produces fair yields of corn and oats. Its adaptability to the growing of peaches has been recognized in other areas where soil surveys have been made. A good grade of filler tobacco is also produced in other localities. Large yields of sugar cane can be grown, but the quality and color of the sirup indicate that the soil is not generally as well suited to this crop as the deeper sandy soils bordering the bottom lands. Where this soil occurs upon the steeper hillsides and about the heads of gullies it should be allowed to remain in forest, because of the tendencies to excessive erosion.

Wherever this type has been cropped continuously to cotton and corn without rotation or the application of fertilizers, the yield of cotton has fallen as low as one-eighth bale per acre and of corn to 10 or 15 bushels per acre. On the other hand, the yields of these crops have been proportionally increased by the application of commercial fertilizers in varying quantities, the usual application being from 200 to 600 pounds per acre in the proportion of 100 pounds of acid phosphate to 200 pounds of cotton-seed meal.

The necessity of deeper plowing and more thorough cultivation is becoming generally recognized by the farmers who study the needs of their soils. The practice of growing legumes as a source of available nitrogen, and the use of cover crops or catch crops to prevent washing and as a means of supplying humus to the soil, is especially recommended to those who cultivate the Orangeburg sandy loam.

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This soil is generally valued at from $5 to $20 an acre, depending upon its location and access to market.

The results of mechanical analyses of the soil and subsoil are given in the following table:

Mechanical analyses of Orangeburg sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18968	Soil	0.8	12.4	17.1	35.6	7.9	19.0	7.1
18969	Subsoil	.2	9.7	10.2	24.9	5.4	17.1	32.3

ORANGEBURG SAND.

The soil of the Orangeburg sand varies in depth from 4 to 8 inches and consists of a brown to gray loose, incoherent sandy loam of medium texture. Below this the material is a loamy sand of a reddish color, which at depths varying from 18 to 36 inches grades into a dark-red sandy clay.

The Orangeburg sand occurs largely in the central and northern parts of the county. The largest connected area of it occurs as an irregular shaped body about 4 miles northwest of Prattville. The next largest area occurs from 3 to 4 miles southwest of Billingsley, in the northwestern part of the county, where it is developed as a succession of irregular bodies linked together into one continuous area. In that section of the county it is similar in texture and structure to the Norfolk loamy sand. The red color and shallow depth of subsoil are the essential features upon which the separation was based. Smaller areas occur throughout the other upland sections of the county. A few small areas were mapped on the river plains, where it occurs as outcrops of the original formaiton.

This type occurs largely upon the uplands, and its usual surface features are hilly and broken. Where it is associated with the Orangeburg fine sandy loam or the Orangeburg sandy loam it generally occurs upon the sides or at the base of slopes extending into the narrow valleys. Its drainage in general is excellent.

The Orangeburg sand is derived from sands and clays of somewhat doubtful age. The materials of the Lafayette and of the noncalcareous Cretaceous formations, exposed in places in this region by the removal of the Lafayette, are somewhat similar.

Millions of feet of high-grade pine lumber have been cut in the last few years from areas of this soil. The present growth is largely scrub-oak or black-jack, with a scattered growth of pine. Not more than a third of the area of this soil has thus far been cleared and put under cultivation.

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For the first two years after clearing it yields from 10 to 20 bushels of corn and from one-fourth to one-half bale of cotton per acre. Continued cultivation to these crops, without recourse to rotation of crops to maintain the land, soon results in diminished yields and the planters find it necessary to use commercial fertilizers. The type is especially adapted to cowpeas, and the growing and plowing under of this crop is probably the most practicable method of increasing its productiveness. Experiments have shown that stable manure is the most efficient fertilizer that can be used.

When it is desired to produce vegetables for early market this type of soil is better suited for the purpose than either the Orangeburg fine sandy loam or sandy loam. It is also well adapted to sweet potatoes, watermelons, cantaloupes, and peaches. In some sections of the South wrapper-leaf tobacco is grown upon this soil. At present the Orangeburg sand is being largely used as a range for live stock. The native grasses and tender shoots of shrubs furnish fairly good pasturage.

Land of this type of soil is rarely sold separately. Included with other types it brings from $7 to $15 an acre, exclusive of the timber rights, which are usually sold separately.

The average results of mechanical analyses of the soil and subsoil of this type are given in the following table:

Mechanical analyses of Orangeburg sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18984, 18986	Soil	0.5	20.7	21.4	33.4	5.6	10.9	7.1
18985, 18987	Subsoil	.3	10.7	20.3	31.1	5.4	11.6	20.6

ORANGEBURG CLAY.

The Orangeburg clay consists of about 4 inches of dark-red to reddish-brown sandy loam to loam, resting upon a red sandy clay subsoil which extends to 36 inches or more.

The largest area of this type occurs above Bonita and extends in a northwesterly direction. Another large area occurs one-half mile east of Figtree Church, and one about 1 mile northwest of Harmony Church. Other smaller areas are found scattered about the county, usually associated with the Orangeburg fine sandy loam and sandy loam. The Orangeburg clay is found in the higher parts of the uplands. Its topography is in some cases very hilly, but it also occurs as high level areas. Its elevated position and broken topography insure excellent drainage. If care is not taken to protect the fields by means of winter cover crops and by terraces, serious erosion is apt to

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take place. The Orangeburg clay is derived from the Lafayette formation.

The native vegetation consisted of pine, oak, and dogwood, but most of this has been removed and the land has been put under cultivation. The type is regarded as the strongest of the Orangeburg soils, and is well suited to general farming purposes, including stock raising. Cotton yields from one-fourth to two-thirds bale and corn from 10 to 15 bushels per acre. Oats also do well.

In the case of such heavy soils as the Orangeburg clay deep plowing is particularly advantageous. The soil materials where unbroken are penetrated with difficulty by plant roots and the shallower the seed bed the more circumscribed is the feeding zone. Deeper plowing enables a wider spreading of the root system and a more perfect development of the plants in general, with a consequent increase in the yields. It also affords a larger reservoir for moisture, enabling the crops to pass with safety through much longer periods of drought.

The soil is usually deficient in humus. Stable manure is probably the best fertilizing substance that can be used; but its use is restricted in this region, as comparatively little live stock is kept and little attention given to conserving the available supply. The turning under of cowpeas is a practicable and economical method of building up this soil. In the winter a catch crop of oats, crimson clover, rye, or vetch should be grown as winter cover crops. They not only prevent the soil from washing, but afford winter pasturage and later may be cut for hay or turned under. In the absence of live stock there is no better way to supply humus to the soil than to use these crops for green manuring. The type is valued at from $8 to $15 an acre.

The following table gives the results of mechanical analyses of soil and subsoil:

Mechanical analyses of Orangeburg clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18892	Soil	0.5	3.0	9.0	39.0	5.9	18.9	24.4
18893	Subsoil	.1	1.8	8.7	26.7	4.5	10.5	47.7

KALMIA FINE SANDY LOAM.

The soil of the Kalmia fine sandy loam to a depth of 8 to 30 inches, with an average depth of 15 or 18 inches, is a dark-gray to brown fine sandy loam. At the lower depths the color becomes yellowish, being similar to the upper portion of the subsoil. The subsoil is a yellowish

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sandy clay, which becomes heavier in texture with depth. It is sometimes slightly mottled below 30 or 36 inches.

The Kalmia fine sandy loam is sedimentary, being derived from materials of Pleistocene age. It is confined to the first and second terraces along the Alabama River and its tributaries, including Autauga, Swift, Buck, and Little and Big Mulberry creeks. The largest areas occur 1½ miles northeast of Autaugaville and in the vicinity of Vinehill, Jones, and Fremont. Other areas occur in the several bends of the Alabama River and along other streams.

The topography is gently undulating to sloping and the drainage is usually adequate for the average rainfall, but during stages of high water this type is occasionally partially inundated or is too wet for cultivation. The soil shows a tendency to "pack," but is generally easy to cultivate and does not suffer readily from drought if properly mulched. Artificial drainage is usually necessary to insure the best returns.

The native vegetation consists of water oak, pine, sweet gum, hickory, dogwood, and various kinds of shrubbery.

This type is best suited to corn, yielding from 10 to 20 bushels per acre, but where the subsoil is shallow and the soil has been well drained cotton yields from one-fourth to one-half bale per acre. Cotton grown upon this land is not subject to stain, as that grown upon the upland soils. If well drained this type should be fairly well suited to trucking, including peas, beans, cucumbers, raspberries, blackberries, and strawberries. It is especially suited for Johnson and Bermuda grasses and pasture. A fine grade of light sirup is also produced on this soil.

For general farming purposes this type is usually held at from $10 to $20 an acre, although at present very little is offered for sale.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of the Kalmia fine sandy loam:

Mechanical analyses of Kalmia fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18349	Soil	0.1	2.5	3.6	26.5	20.6	44.1	8.4
18350	Subsoil	.1	1.3	2.5	15.5	14.4	46.3	19.4

NORFOLK FINE SANDY LOAM.

The soil of the Norfolk fine sandy loam consists of a grayish light-brown fine sandy loam of uniform texture, ranging in depth from 6 to 20 inches. In the lower depths of the soil proper the color be-

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comes yellowish gray and the texture is slightly heavier. The subsoil is a bright yellow sandy clay or heavy fine sandy loam extending to a depth of 36 inches or more. The lower part of the material is frequently mottled by iron stains. Iron concretions are occasionally found strewn upon the surface and disseminated throughout the soil.

This soil type usually has a loose friable structure, and when first cleared and put under cultivation is quite loamy, owing to the organic matter incorporated with it. It loses this characteristic to some extent after a few years of cultivation and shows a slight tendency to compact upon the surface after a hard rain, but does not bake or crack like some of the heavier soils. On account of its loose, incoherent structure and sandy texture it warms up early in the spring and is easy to till.

The surface of the Norfolk fine sandy loam is level to gently rolling, with enough irregularity to insure fairly good natural drainage. There are very few areas that can not be easily drained. The effects of fertilization are more lasting than with soils having looser and more incoherent subsoils.

Norfolk fine sandy loam is found upon the upland. It is confined almost entirely to the southern half of the county. It is derived principally from the weathering of the sand and clays of Lafayette age, to which the Pleistocene has probably made some contribution.

The native forest growth consisted of liveoak, water oak, and pine. Some marketable timber is still standing, but the greater proportion of these lands have been cleared and under cultivation for a good many years. When abandoned the fields soon become covered with a rank growth of broomsedge.

Cotton and corn are grown almost to the exclusion of other crops. The ridge method of cultivation is the common practice as with most of the other soil types in the area. No definite system of crop rotation is practiced, and commercial fertilizers are depended upon to maintain the yields. A few of the better class of tenants and owners plant cowpeas or peanuts between the corn rows, and a few of them have extended this practice to the cotton fields as well. This aids materially in building up the soil.

In general the average yield of corn on this soil ranges from 8 to 10 bushels per acre where no fertilizer is used. These yields are increased from 10 to 20 bushels by applying commercial fertilizers. With fertilization cotton yields from one-third to one-half bale per acre.

Better results than at present could be obtained by plowing this soil in the fall with a two-horse breaking plow, leaving it until spring for harrowing and reworking. A still better plan would be to plow the land deeply, harrow it thoroughly, and sow a cover crop, oats and rye, or vetch in the fall. In this way the tendency to wash and

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leach will be retarded, a winter pasturage for stock afforded, and a crop of hay secured. The action of the roots of these crops will put the soil in a better physical condition, while the organic matter in the roots and stubble will add to the supply of humus.

This is one of the best strawberry soils in the area, although none of it is being used for this crop at the present time. It is also well adapted to peas, beans, radishes, beets, carrots, sugar corn, Irish potatoes, cabbage, sweet potatoes, and sugar cane. A very large part of the type is too far from market, however, to be used for trucking, with the present facilities.

In other parts of the South an excellent grade of wrapper tobacco is being produced upon this soil, and it is believed that where the soil is 15 or 20 inches deep there are possibilities in this direction in the present area. The land is valued at $10 to $14 an acre.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of the Norfolk fine sandy loam:

Mechanical analyses of Norfolk fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18970	Soil	0.3	1.6	2.0	32.0	17.4	37.7	8.6
18971	Subsoil	.2	1.1	1.6	27.0	16.9	29.4	23.8

KALMIA SANDY LOAM.

The Kalmia sandy loam, to a depth of 8 to 24 inches, with an average depth of 10 or 12 inches, is a dark-gray, brown, or gray sandy loam of medium, or medium to coarse texture. The upper portion of the soil is usually quite dark in newly cleared areas, but after a few years of continued cultivation the soil becomes "leached" and a lighter gray. At the lower depths the color changes to a yellowish hue, being of the same color as the upper portion of the subsoil. Where this type occurs adjacent to stream courses or old river channels there are small areas in which the surface soil has a loose, gravelly sandy structure. These areas were not of sufficient extent to warrant mapping as a distinct type. The subsoil is a yellowish or slightly reddish sandy clay, usually becoming heavier with depth and frequently showing mottling below 30 inches.

The largest areas of the Kalmia sandy loam occur in the vicinity of Autaugaville and along Autauga, Big and Little Mulberry, Swift, and Buck creeks and upon the Alabama River terraces. Autaugaville and a portion of Prattville are upon this type. The Kalmia sandy loam is not so extensively developed in this county as the Kalmia sand. It is of about the same average texture, but on

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account of the clay foundation is a much more productive soil than the deeper sands. This type is not naturally so well drained as the upland soils, but where it occurs upon the second terraces it is usually easy to drain artificially and is much more productive, especially for corn and hay, than the "gray land" (Norfolk sandy loam) of the uplands. This soil also suffers less from drought than the Norfolk sandy loam, but is often inundated at times of heavy rains. Artificial drainage is usually necessary to obtain the best results from this type.

The Kalmia sandy loam, like the other members of the Kalmia series, is of Pleistocene alluvial origin, and occupies the first and second terraces along the Alabama River and its tributaries. The topography is flat to gently undulating or sloping.

The native growth upon this soil is pine, water oak, sweet gum, hickory, elm, and other deciduous trees and shrubbery.

This type is best suited to corn and hay, but is also used for cotton. Its water-holding capacity, being usually well supplied with moisture, makes it especially suited for grasses and pasture, the hay produced being more nutritious than that usually obtained from the lighter upland soils. Bermuda grass has been grown extensively upon this type, yielding from 1 to 3 tons per acre. The better drained areas are suitable for trucking, but the type as a whole is not so well adapted to this industry as the warmer Norfolk sandy loam upon the uplands.

This type is valued at from $5 to $10 an acre, according to location and improvements.

NORFOLK SANDY LOAM.

Norfolk sandy loam to an average depth of 18 to 20 inches consists of a grayish or yellowish medium-textured sandy loam. The first 2 or 3 inches of the surface material is sometimes brownish and is a little finer textured than the underlying soil. The subsoil to 3 feet or more is yellowish in color and varies from a heavy sandy loam to a sandy clay in texture. Where it comes within 15 inches of the surface the texture is somewhat heavier, and instead of the even yellow color the material is mottled with reddish and brownish iron stains. Adjacent to some of the stream courses and old stream channels a few small gravelly sandy loam areas were included with this type.

The soil, except in the virgin state, is very apt to be deficient in humus, and for this reason is generally referred to as a "weak" soil. It is as dependent upon the use of commercial fertilizers to secure a paying crop as the Norfolk sandy loam. It is for the most part loose and friable, which insures good drainage, while the same open structure makes it a warm soil and favors early cultivation.

This type occurs chiefly in the southern half of the county. The next largest body occurs east and south of Mulberry. The town of

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Autaugaville stands upon this type. A few scattered areas were mapped in the northern half of the county in the vicinity of Boothe, Rayshill, and Marbury. These have the same origin as the Norfolk loamy sand, the main difference between the two types being the difference in depth of soil, the sandy loam type having less than 3 feet of loamy sand resting upon a yellowish sandy clay formation.

For the most part the surface of this type is flat. In small areas it is slightly undulating, and here the drainage is sufficient in seasons of normal rainfall, but in the larger flat areas it is usually necessary to supplement the natural drainage by open ditches. A few small depressed or seepage areas occur throughout the type. The soil in these is usually a rich loam, which when reclaimed by drainage produces large yields of cotton and corn, and is especially well suited to sugar cane.

The origin of this type is practically the same as that of the Norfolk fine sandy loam. The type is formed from the weathering of the sands and clays of the Lafayette formation.

The native forest growth upon this soil was longleaf pine, water oak, and persimmon. Practically all the marketable timber has been removed and the greater proportion is under cultivation.

Most of the truck crops may be grown successfully on the Norfolk sandy loam. It is also a good soil for peaches, plums, strawberries, blackberries, sweet potatoes, and sugar cane. Aside from the home garden very little of this type is at present used for trucking. Occasional patches of watermelons and cantaloupes are grown for the local markets. The growing of lima beans, string beans, green peas, etc., could be developed into a paying industry. The selection and improvement of cowpeas and peanuts for seed purposes could be successfully conducted upon this soil and the yields of these crops materially increased. Strawberries could be forced to an early maturity and made to produce good yields with proper fertilization. Along the Atlantic coast the Norfolk sandy loam is used extensively for strawberry culture with profitable results.

This type, like most of the soils of the county, is cropped almost exclusively to corn and cotton. The practice of planting cowpeas between the corn rows is followed by some of the farmers who cultivate the Norfolk sandy loam, but it is exceptional to find cowpeas planted separately or with the purpose of rotating the crops. A good rotation of this soil is cotton, corn, oats, and cowpeas, sowing the cowpeas between the rows of cotton and corn and as a catch crop after the harvesting of the oats. Deeper plowing, with shallower after cultivation, is also recommended. Over the greater part of this soil the surface conditions favor the use of labor-saving machinery.

Corn yields from 10 to 15 bushels and cotton from one-fourth to one-half bale per acre. These yields are considerably increased where

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a system of crop rotation is practiced and humus is put back into the soil. Johnson grass yields from 2 to 3 tons per acre. The finer textured bodies of this soil, having a yellow sandy clay subsoil at from 10 to 20 inches below the surface, could be used for growing bright tobacco. A fairly good grade of wrapper-leaf tobacco has been produced upon this soil in other sections of the South. With successful cigar factories already established in the county, this might become a paying industry here as in other counties of the State. The type is generally valued at from $10 to $15 an acre, according to location and markets.

The results of mechanical analyses of soil and subsoil of this type are given in the following table:

Mechanical analyses of Norfolk sandy loam.

Number.	Description.	Fine gravel.	Coarse. sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18043	Soil	0.6	25.3	16.7	32.0	6.6	13.9	4.4
18044	Subsoil	.0	15.9	19.3	30.0	7.2	15.7	10.9

KALMIA SAND.

The Kalmia sand, to an average depth of 10 to 12 inches, is a medium to coarse textured, grayish or brownish loamy sand or sandy loam. In its virgin state the first few inches of the soil is quite dark and loamy, owing to greater abundance of organic matter. The subsoil to 36 inches is a yellowish, rather loose, incoherent loamy sand of slightly coarser texture than the soil.

The Kalmia sand occurs on the level or slightly undulating terraces of the larger streams in the southern part of the county. These terraces owe their origin to deposits of sandy materials which were laid down by the larger streams during early flood periods and before these stream channels were lowered to their present levels. There are a few locations where the type is still in process of formation.

Originally the vegetation upon this type was chiefly shortleaf and longleaf pine, water oak, persimmon, and blackjack. Practically all the marketable timber has been removed and a large proportion of the type is now under cultivation in cotton and corn.

In many localities along the Atlantic this soil is used extensively for trucking and by heavy fertilization large yields of lettuce, peas, radishes, early Irish potatoes, cantaloupes, cucumbers, watermelons, strawberries, and other special products are obtained. In Autauga County, however, up to the present time very little attention has been given to trucking, except in the growing of watermelons and cantaloupes for the local markets. There appears to be no reason why

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this industry should not be developed on a commercial scale in Autauga County.

With the usual methods of cultivation and fertilization corn produces from 7 to 10 bushels and cotton from one-sixth to one-third bale per acre. Where this soil is highly fertilized double these yields may be obtained. Sugar cane, producing a very good quality of sirup, can also be grown upon this soil, although the yield is not as large as on some of the other soil types. The soil is especially adapted to peanuts, which may be made a valuable crop in connection with hog raising, the hogs being fattened by being turned into the field to gather the nuts.

The Kalmia sand is generally deficient in organic matter and responds to applications of barnyard manure or plowing under of some of the legumes, preferably cowpeas. Where the growth is heavy the best results will be obtained by applying lime to the field before plowing the vines under. The use of lime in combination with a complete fertilizer has also been found beneficial, but unless some means is provided for maintaining the humus content of the soil the yields soon diminish.

This soil is usually valued at $5 to $10 an acre and is generally leased to tenants who give one-half the produce for use of the land.

The following table gives the results of mechanical analyses of typical samples of the soil and subsoil:

Mechanical analyses of Kalmia sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18415, 18966	Soil	0.2	22.5	32.9	27.2	2.4	11.2	3.3
18416, 18967	Subsoil	.3	20.3	32.5	28.9	2.4	10.9	4.5

CAHABA FINE SANDY LOAM.

The soil of the Cahaba fine sandy loam is a light-brown to reddish-brown fine sandy loam ranging in depth from 5 to 10 inches, with an average depth of about 7 inches. The material of the first few inches is usually slightly darker, owing to the presence of small quantities of organic matter. The subsoil is a light-red heavy fine sandy loam grading gradually into a dull-red sandy clay at a depth of about 30 inches. Below this the subsoil is mottled red, yellow, and gray, and the texture of the material becomes much lighter. Both soil and subsoil contain more or less mica flakes.

Development of the soil is confined to the second terraces of the Alabama River and its tributaries. The largest area occurs in the western portion of Dutch Bend. Another area of about the same

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size lies south of Prattville and there are areas in Days Bend and throughout the river plains, including those in Big Mulberry Creek Valley.

The topography of the Cahaba fine sandy loam is flat to very gently undulating. The greater proportion of the type has a fairly well developed natural drainage, though in areas occurring in the level plains artificial drainage is usually necessary. On the whole the natural drainage, however, is somewhat better than upon the Cahaba silt loam. The Cahaba fine sandy loam is derived from the weathering of sands and clays of Pleistocene age.

The native vegetation consisted of sweet gum, water oak, pine, black gum, persimmon, and elm, the greater portion of which has been removed and the land put under cultivation. The type is a desirable one for general farm purposes and it is not usually allowed to stand idle. It is well adapted to cotton and corn, and with an application of 200 to 400 pounds of acid phosphate and cotton-seed meal yields of from one-fourth to one-half bale of cotton and from 15 to 30 bushels of corn per acre are obtained. The effect of commercial fertilizers is materially increased by maintaining a goodly supply of humus in the soil.

The most practicable method of incorporating organic matter in the soil is by growing legumes, though where available stable manure gives even better results. Applications of lime in connection with organic manures markedly increases their efficiency.

Oats yield from 15 to 30 bushels per acre, and this is a valuable crop either for grain, hay, or winter pasturage. Peanuts produce well, and not only enrich the soil but furnish the best of forage for hogs. They should be planted between the corn rows and cultivated at the same time as this crop. Sugar cane produces large yields of sirup of good quality.

As with many of the soils, this type should be plowed in the fall so that the fall and winter rains may sink into it and be available for the growing crops during seasons of drought. It is a warmer soil than Cahaba silt loam and can be cultivated earlier in the spring, while it is not so susceptible to drought later in the season as the latter type.

A large percentage of this soil is farmed by tenants who ordinarily plow to a depth of 3 or 4 inches only. Under such conditions its natural productiveness is but partially brought out. Like most soils in the county, the breaking is done with a one-horse plow or is bedded up without previous breaking. Deeper plowing and shallower after cultivation should be substituted for the present methods.

The value of this land ranges from $7 to $20 an acre. Most of it is held in large tracts and is not under the direct management of the owners.

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The following table gives the results of mechanical analyses of soil and subsoil of this type:

Mechanical analyses of Cahaba fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
17525	Soil	0.0	2.3	10.3	43.3	12.0	29.7	2.7
17526	Subsoil	.7	3.4	9.7	25.2	7.2	44.7	9.6

MYATT SANDY LOAM.

The soil of the Myatt sandy loam from 8 to 20 inches consists of a dark-gray medium to fine sandy loam. Sometimes there are large amounts of organic matter present, and this imparts to the soil a dark-brown color. The subsoil is grayish in color and varies in texture from a heavy sandy loam to a sandy clay. At a depth of about 3 feet the material is stiffer and more plastic and is mottled with iron stains.

This type occurs upon the river terraces in the southern part of the county, the largest area being found about 1 mile northeast of Forester Station. Other areas are found southwest of Kalmia, west of Autaugaville, and in the vicinity of Prattville, and also in Big Mulberry Creek valley.

Usually the areas of the soil which are practically level or slightly depressed are poorly drained. Frequently a hardpan condition of the soil is encountered at varying depths below the surface, and this retards the movement of the ground water. The type is regarded as a cold soil and difficult to handle in the early spring.

Like the Cahaba soils, this is derived through weathering from deposits of Pleistocene age, which form the terraces along the Alabama River and some of the more important tributaries of that stream. The native vegetation is principally bay, poplar, gum, shortleaf pine, with an undergrowth of shrubs and vines.

A few small areas of this type of soil in the vicinity of Prattville have been used for cabbage and other truck crops, and this soil seems well adapted to trucking. Cauliflower, lettuce, turnips, beets, and Irish potatoes give good results. Irish potatoes should be grown upon the better drained areas only. Tomatoes make a vigorous growth of vine, but often fail to fruit satisfactorily. Small fruits, such as strawberries, raspberries, blackberries, currants, and gooseberries, could be grown with profit upon the better drained areas. The soil is well adapted to Johnson and Bermuda grasses, and yields of 2 to 3 tons per acre are obtained. An abundance of water from flowing wells at a depth of 50 to 200 feet is obtainable, and this,

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together with the adaptation of the soil to grass, makes it valuable for stock raising and dairying. Corn yields from 20 to 50 bushels per acre, when heavily fertilized, and oats from 30 to 40 bushels per acre. Sugar cane also does well.

In order to get the best returns from this soil, it is necessary to improve its physical condition. It is a comparatively simple matter to do this by draining with open ditches, by deeper plowing, preferably in the fall, and by turning under legumes. Experiments with the wire-basket methods have shown that applications of lime at the time the green manuring crops are turned under increase decidedly the beneficial effects of the organic matter. The liberal use of manure, either alone or with light applications of lime, will probably give as good results as plowing under a leguminous crop, but under existing conditions in the county where little live stock besides the work animals is kept the available supply of manure is far from sufficient to meet the requirements, and the most practicable way of managing the soil is to introduce a rotation of crops, including cowpeas, some of the clovers, or winter vetch, to be used as green manuring crops.

For general farming the soil is valued at $10 to $15 an acre, but where it is in close proximity to market it is held at higher prices for trucking and dairying.

The following table gives the results of mechanical analyses of the soil and subsoil of the Myatt sandy loam:

Mechanical analyses of Myatt sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18946	Soil	1.9	19.0	18.0	29.2	13.5	13.1	5.2
18947	Subsoil	2.4	14.0	16.1	27.1	9.9	20.4	10.0

CAHABA SILT LOAM.

The Cahaba silt loam consists of a brownish or yellowish-gray friable loam or silty loam varying in depth from 4 to 10 inches, with an average depth of about 6 inches. The texture of the subsoil is somewhat heavier than that of the soil to about 30 inches, but below this it becomes a little coarser. The color varies from yellowish-gray in the upper portion to bright yellow at a depth of about 24 inches, and below this the material becomes distinctly mottled with red, yellow, and gray.

Where well drained the Cahaba silt loam is usually an easy soil to cultivate, but care must be taken not to plow when it is wet or serious difficulty will be experienced, the soil grains running together and the surface baking hard.

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The soil of this type is confined to the southern part of the county in the neighborhood of the Alabama River. The largest area occurs 7 miles southwest of Prattville and other areas of considerable importance were mapped in Dutch and Day's bends on the river. It occurs upon first terraces and is sometimes associated with old abandoned channels a considerable distance back from the present stream. The soil is alluvial in origin, having been deposited in Pleistocene time. Its most typical development has been in the large bends of the stream. In its virgin state it is often in a semiswampy condition, especially during the rainy season, and usually before the land can be successfully cultivated it has to be drained.

Deeper plowing and better drainage, together with applications of barnyard manure and the growing of leguminous cover crops, would tend to keep the soil from "running together" and result in larger yields. The use of lime would cause the soil to flocculate and remove its tendency to compact.

Cotton is the leading crop and very little attention has so far been given to crop rotation. The soil is well adapted to both cotton and corn, the former yielding from one-fourth to one-half bale of cotton and 15 to 25 bushels of corn. Commercial fertilizers are used to some extent, the most popular application being a mixture of cotton-seed meal and acid phosphate. The most important change in the plan of cultivation is the adoption of some systematic rotation of crops in which a leguminous crop, either cowpeas, clover, vetch, or soy beans, is included with oats and rye as winter cover crops. Whether these crops are turned under as green manuring crops or not they will add considerable organic matter to the soil and maintain a supply of humus, of which the soil is badly in need. The land is held at from $7 to $10 an acre.

The following table gives the average results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Cahaba silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18351, 18950	Soil	1.2	2.5	2.9	6.4	10.4	57.9	19.1
18352, 18951	Subsoil	.0	.6	.7	1.7	3.3	58.1	35.7

GREENVILLE FINE SANDY LOAM.

The Greenville fine sandy loam consists of a brownish or reddish fine sandy loam varying in depth from 5 to 12 inches, with an average depth of about 8 inches. The subsoil is a dark-red to brick-red medium sandy or fine sandy clay which changes to a lighter colored

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sandy loam at about 36 inches. Where the subsoil is close to the surface, the subsoil material is sometimes turned up in plowing, causing the fields to be quite red in spots. On the other hand, where the soil is deep or where there are small depressed areas in which water stands after heavy rains, the surface soil is rather dark colored.

This soil type is confined to the southern half of the county and is especially well developed in the vicinity of Prattville, Mulberry, and Huckabee. It occurs as flat to gently rolling areas and the drainage is adequate only in seasons of average rainfall.

The Greenville fine sandy loam, like the sandy loam, is derived from the weathering of the sands and clays of the Lafayette formation. The native timber has been almost entirely removed and the greater proportion of the land is under cultivation. Eroded spots, where the subsoil has been exposed, are usually permitted to grow up to wild plum trees and old field pine. The occurrence of these patches makes fields irregular and more difficult to cultivate. A better practice would be to build terraces where erosion is active, remove the growth, and plow the soil deeper so that it will be able to absorb a large proportion of the rainfall. In the course of a few seasons these gall spots could be reclaimed and made as productive as the remainder of the fields.

Under the present methods of cultivation the Greenville fine sandy loam, which is naturally well adapted to cotton, produces the rather low average yield of one-third to one-half bale per acre. The yield can be greatly increased by deeper plowing and more thorough cultivation and the growing of legumes and winter cover crops. In this way the water-holding capacity of the soil will be improved and the supply of humus, which has been diminished by continuous clean culture, will be maintained in sufficient quantity to meet the requirements of the crops.

Owing to the flat, gently rolling topography of the soil it is well adapted to the use of labor-saving machinery. It has been successfully demonstrated upon the soils of similar character that the planting of cotton and corn in checks, so that it can be cultivated in two directions, one at a right angle to the other, not only increases the yields but reduces considerably the expense of cultivation.

The average yield of corn varies from 10 to 20 bushels per acre, but with better methods of cultivation and seed selection these yields may be greatly increased. The oat crop also does well, but most of it is cut for hay, so that no definite figures can be given for the yield of grain. Cowpeas are grown considerably for forage and the acreage of this crop should be extended.

Farms consisting of the Greenville fine sandy loam are valued at $10 to $30 an acre, according to their location with regard to shipping point and local market.

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The following table gives the results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Greenville fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19000	Soil	0.9	6.4	14.6	33.7	10.7	19.9	13.7
19001	Subsoil	.5	4.4	9.8	23.9	8.4	22.2	30.7

GREENVILLE SANDY LOAM.

The soil of the Greenville sandy loam is a dark-brown or reddish-brown loam or sandy loam varying in depth from 5 to 12 inches, with an average of about 8 inches. To a depth of about 30 inches the subsoil is a dark-brown to red, moderately stiff, sandy clay, which attains its maximum clay content between 20 and 30 inches below the surface. This soil is known locally as "mulatto land." It is a fairly uniform type, although some variation is found in small depressions which receive the wash from higher ground, the soil being somewhat heavier and darker in color than the typical areas.

The largest single area of this soil type occurs about 2 miles southwest of Autaugaville and is known as the "Pickett level." Another area lies immediately north of this and is practically a continuation of it. The "Montgomery level," which is located 2½ miles southeast of Prattville, embraces another large area. Other areas occur in the vicinity of Mulberry and scattered throughout the southern part of the county.

The Greenville sandy loam is an upland type, occurring as flat or rather gently undulating table-lands or plateaus, with rather poor surface drainage. Owing, however, to the friable character of the soil and subsoil the underdrainage is good, although this could be somewhat improved by tile drains. The surface drainage may also be improved by deeper plowing, enabling the soil to absorb more of the rainfall. When properly handled the soil can be readily put in good tilth. In origin the Greenville sandy loam is the same as the Orangeburg soils, being derived from the Lafayette formation. Originally the areas supported forests of pine, oak, hickory, and dogwood. Practically all the timber has been removed and the land put under cultivation. Its level topography and occurrence in large bodies favor the use of labor-saving machinery.

This soil is particularly well adapted to cotton, and though under the present methods of cultivation the yields are only one-half bale per acre, with proper cultural methods, including a rotation of crops, it can be made to yield a bale to the acre. Corn and oats also pro-

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duce fair yields upon this type; the former, under the best management, can be made to yield 30 to 50 bushels per acre. Cowpeas could be grown not only for forage but as a green manuring crop. Oats and vetch with rye are as valuable as a winter cover crop on this soil as in the case of soils already described.

This soil is well adapted to trucking and is especially suited to tomatoes and Irish potatoes. Blackberries, raspberries, currants, gooseberries, and strawberries also do well.

Land of this character is generally held in large tracts and is not usually for sale. Its estimated value ranges from $8 to $30 an acre.

The results of mechanical analyses of soil and subsoil of this type are given in the following table:

Mechanical analyses of Greenville sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18041	Soil	1.4	19.8	17.3	24.3	7.3	18.5	11.5
18042	Subsoil	.7	13.5	10.3	17.8	5.4	18.7	32.9

GUIN GRAVELLY SANDY LOAM.

The Guin gravelly sandy loam consists of 10 inches of a dark-gray or brownish, gravelly, fine to medium textured sandy loam, resting upon a subsoil which to a depth of 2 feet is slightly heavier in texture and of yellow-brown color, at which point it grades into a sandy clay, the color sometimes changing to red.

The percentage of gravel and other coarse material is less in the subsoil than in the soil and diminishes with depth. In the vicinity of stream courses and around the heads of streams, where erosion has been greatest and where the surface is often hilly or broken, the type occurs in the most gravelly phase. The percentage of gravel is also higher upon the hilltops and crests of ridges, where the surface is frequently so thickly strewn with quartz gravel as to render the land of little or no value for agriculture. The purplish sands and clays of the underlying formation occasionally outcrop in spots at the surface and give rise to a heavier phase of the type. Sometimes where this type occurs adjacent to the Orangeburg fine sandy loam or sandy loam its subsoil resembles that of the latter types. Among the hills which form the bluff lines of the Alabama River small patches of the soil are found, but these are usually so eroded that the clayey subsoil is often exposed. The type occurs in the northwestern and northeastern parts of the county. In the northwestern part a good many iron concretions are found in the soil. Elsewhere the areas

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are more level and the soil in many places is comparatively free from gravel. On gentle slopes adjacent to stream courses the material to a depth of several feet is sometimes a sandy gravelly loam.

The topography of the Guin gravelly sandy loam varies from undulating to hilly, and in some places is quite precipitous, with pointed knolls and sharp ridges. The drainage is usually very good, but on account of the surface coating of gravel and small stones erosion is not as severe as on many of the soils of the area where the topography is similar. It is never necessary to drain this type artificially.

The Guin gravelly sandy loam is derived from gravelly layers of the Lafayette formation. The erosion of these layers has removed the finer particles of sand and clay and left an accumulation of gravel at the surface. The soil was at one time covered with a fine growth of longleaf and shortleaf pine, but the timber has been largely removed. A scattering growth of pine, white oak, post oak, dogwood, hickory, and blackjack oak constitute the present forest growth.

The native grasses and tender shrubs furnish fairly good grazing for hogs, sheep, and cattle.

Owing to the gravelly nature of this type of soil, it is as a whole difficult to cultivate. Only a small percentage of its area is at present farmed. Cotton yields from one-fourth to two-thirds bale and corn from 12 to 25 bushels per acre. Both plowing and cultivation are usually shallow. Crops planted on this type suffer less from drought than the sandier soils, while they are not injured by abnormally wet seasons.

The Guin gravelly sandy loam is especially well adapted to grapes, and with proper shipping facilities and markets a paying industry could be developed. Plums, peaches, pears, and apples produce well and the fruit is of excellent quality. Land of this type is generally held at $5 to $15 an acre. It is owned mostly in large tracts by lumber companies. It is being gradually cleared and put upon the market. At present its chief value, aside from timber, is for grazing.

The following table gives the average results of mechanical analyses of fine-earth samples of both soil and subsoil:

Mechanical analyses of Guin gravelly sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18952, 18954.....	Soil.....	4.4	22.5	15.1	20.4	6.7	23.1	7.5
18953, 18955.....	Subsoil.....	2.2	18.1	14.6	20.2	5.9	22.1	16.7

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NORFOLK LOAMY SAND.

The Norfolk loamy sand consists of a grayish or brownish, fine to medium textured sandy loam with an average depth of about 10 inches, resting upon a yellowish or brownish colored sandy loam. Sometimes there is rather a large percentage of coarse angular sand in both soil and subsoil. In cuts the subsoil material seems to be sufficiently coherent to stand in perpendicular walls, but when dug it is loose and friable.

Along the crests of the steeper ridges where erosion has been active there often occurs a grayish or purplish sticky sandy clay, and here the soil is more coherent. In the vicinity of stream courses iron concretions and gravel are often found. This type occurs chiefly in the north-central and northeastern parts of the county, and extends south as far as Booth. Smaller areas are found about 4 miles north and 3¾ miles northeast of Prattville. The topography is flat to gently rolling, with abrupt escarpments along the streams and gullies. The drainage is always sufficient and frequently excessive, so that crops suffer from drought unless great care is taken to conserve the soil moisture. In wet weather excessive moisture finds a ready outlet through the loose, open-structured soil and subsoil, and the soil has the reputation of being leachy and of soon losing the effects of fertilizer.

The Norfolk loamy sand is derived from a noncalcareous formation of Cretaceous age and represents areas where the Lafayette has been removed by erosion. The native vegetation is chiefly blackjack oak and pine. The native grasses grow in abundance and furnish fair grazing. The type has not been extensively farmed, but by proper cultivation and fertilization it can be made fairly productive.

This soil is best suited to corn, cowpeas, peanuts, fruit, watermelons, cantaloupes, cucumbers, and other truck crops. Peaches, plums, and figs do well both in yield and quality of fruit. Corn does well if the rainfall is plentiful, but is easily affected by drought, the average yield being 12 to 15 bushels per acre. Under favorable conditions yields of 20 to 25 bushels per acre are sometimes obtained. Oats yield from 15 to 30 bushels per acre. Cotton does not do well unless there is an abundance of organic matter in the soil, and then yields ranging from one-fourth to one-half bale per acre are obtained. With the usual cultural methods, however, cotton is very susceptible to rust. Increased use of potash fertilizers seems to be the most practicable remedy for this disease.

The cultural methods practiced upon this soil are not always conducive to the best results. The breaking is done just before planting time with a one-horse plow, the soil being turned to a depth of 4 or

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5 inches only. It is then marked off and the fertilizer applied. In planting corn the seed is dropped on the fertilizer and covered. In planting cotton the field is further prepared by throwing it up in low ridges or beds and the seed planted on the top of this ridge. Frequently the fields are not plowed before bedding, a few furrows being thrown together where the last year rows grew or over the water furrow between the old rows. Nothing more is done until the plants are large enough to cultivate, which consists of barring off, chopping or thinning, hoeing, and thereafter infrequent plowings, generally with sweep plows. The methods employed are being improved upon by two comparatively simple changes. The first plowing should be deeper than at present, the land being broken a little deeper each year until the plow reaches 8 or 10 inches below the surface, but when once the seed bed has been prepared and the plants well started the cultivation should be as shallow as practicable in order that the roots may be disturbed as little as possible. The two main objects of cultivation will be subserved if in the intertillage of cotton and corn 2 or 3 inches of the surface soil are kept in a friable condition.

Cowpeas and peanuts should be grown more extensively. They not only serve to renovate the soil, but make valuable forage for hogs and cattle. They should be grown as a catch crop in corn and as a crop to follow oats. Often it is preferable to plant them so that they may be thoroughly cultivated. Cotton should be planted on this type of soil only when it is in a good state of productiveness. The type offers opportunities for profit in the production of figs, and its texture makes it a good soil for watermelons and cantaloupes, with either of which crops given suitable markets and shipping facilities the average farmer owning this type of soil will be able to make more money than by attempting to grow cotton.

Only a limited acreage is at present under cultivation. It is used extensively as pasture. Its present valuation is governed largely by its standing timber. "Logged off" areas, however, are being offered at $8 to $10 an acre.

The average results of mechanical analyses of the soil and subsoil of this type are shown in the following table:

Mechanical analyses of Norfolk loamy sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18958, 18964	Soil	0.8	16.4	27.8	30.7	4.4	13.9	5.8
18959, 18965	Subsoil	.4	15.1	25.2	33.6	4.9	13.3	7.1

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HUNTINGTON LOAM.

The Huntington loam to a depth of about 10 or 12 inches is a dark-brown loam or fine sandy loam. The subsoil, like the soil, is rather variable in texture, and ranges from a heavy sandy loam to a sandy clay or silty clay. It is of light-brown color and extends to a depth of 3 feet or more. The lighter phase is confined to the better-drained areas and usually lies near the streams. The heavier phase occupies flat or depressed areas. Relatively large quantities of finely divided mica are usually present in soil and subsoil, and this gives rise to the local name of "isinglass land."

The Huntington loam occurs in small bodies and occupies flat, low-lying first bottom in the inner bends of the Alabama River. It occurs in small bodies, the largest of which lies about 7½ miles southwest of Prattville. The next largest area occurs as a crescent-shaped body in the point of Days Bend, near Benton Landing.

This is an alluvial soil composed of sediments deposited by the Alabama River in times of flood.

It is still in the process of formation, being subject to frequent overflow. It is extremely productive, and this condition is maintained by the annual addition of rich sediments. The natural fertility is shown by the dense growth of tall cane and blood weed, which find a natural habitat upon it. These canebrakes afford a good winter pasture. Floods inundating this soil generally occur in the spring and fall, but occasionally in June or July. This limits the use to which the land can be safely put. Corn, taking less time to mature than cotton, is grown almost exclusively. Where the season is favorable, yields of 75 to 125 bushels per acre are sometimes secured. To insure the best results it is necessary to plow the land deep and to pulverize it thoroughly by harrowing, so that the seed bed may be as loose, warm, and well drained as possible. This is one of the most productive soils in the area, but being subject to overflow the crops are somewhat uncertain. In its present state it is held at $10 to $40 an acre.

The results of mechanical analyses of the soil and subsoil of this type are given in the following table:

Mechanical analyses of Huntington loam.

Number.	Description.	Fine gravel.	Coarse. sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18976	Soil	0.2	0.3	0.8	21.2	18.2	39.6	19.5
18977	Subsoil	.0	2.8	13.3	45.2	11.3	17.1	9.9

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OKTIBBEHA CLAY LOAM.

The Oktibbeha clay loam consists of 6 or 8 inches of heavy dark-brown loam or clay loam resting upon a subsoil of slightly mottled yellowish clay which extends to a depth of 12 to 15 inches. Beneath this the material grades into a more distinctly mottled yellow and gray clay. Below 30 inches it is of a light gray and mottled color and is very stiff and plastic. The surface of this type is occasionally strewn with gravel and small stones, and sometimes there are small spots of sandy loam scattered through the areas.

The Oktibbeha clay loam is confined to three comparatively small areas in the vicinity of Autaugaville and the Alabama River. One important body occurs about 3½ miles and another about 6 miles southwest from Autaugaville. The third area extends along the eastern edge of Bear Swamp southeast of Autaugaville. The total area of the type is less than 2 square miles.

The Oktibbeha clay loam is found in the level uplands. The drainage is usually sluggish and, while in ordinary seasons crops may be grown with an excess of rainfall, surface ditches are needed to carry off the surplus water. The underdrainage is also slow, the impervious subsoil retarding the escape of water downward.

The native forest growth is pine, oak, hickory, and poplar. The soil is derived from materials of Cretaceous age and represents areas from which the Lafayette has been removed by erosion.

Melilotus, Bermuda grass, and Johnson grass do well upon this soil and yields of 2 to 3 tons per acre are obtained. No alfalfa has thus far been grown, but it is believed that it would do nearly as well upon this soil as upon Houston clay. Stock raising and dairying are industries which could be profitably introduced.

This soil, owing in part to its low organic content, has a tendency to compact in uncultivated fields, but when properly cultivated it breaks down into a fine loamy mass and becomes a very good soil for cotton and corn. The former crop, which at present gives only one-fourth to one-half bale per acre, can be made to yield as much as a bale. The corn yield is 15 to 20 bushels per acre. Probably as great an increase in this crop as in the case of cotton can be made by the use of improved methods, including deeper plowing and seed selection.

Land of this type of soil in conjunction with other soils may be purchased from $10 to $15 an acre, according to the character of improvements and convenience to markets.

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The following table gives the results of mechanical analyses of fine-earth samples of soil and subsoil:

Mechanical analyses of Oktibbeha clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19004	Soil	2.2	7.4	9.4	18.5	8.0	34.7	19.2
19005	Subsoil	.7	3.4	4.0	8.3	3.9	25.2	54.3

HOUSTON CLAY.

The Houston clay consists of 8 to 15 inches of dark-brown or black clay or clay loam, underlain to a depth of 36 inches or more by a comparatively stiff, light-brown, highly calcareous clay or chalky material. Scattered through both soil and subsoil are a good many fossil shells and nodules of carbonate of lime. Land of this type becomes waxy and gummy when wet and at such times it is practically impossible to plow or cultivate it.

This type is found next to the Alabama River plains, where it occupies level to gently undulating areas. It is known locally as "black prairie land."

In many parts of the Gulf States this type of soil occurs in broad prairie areas and because of its very compact impervious structure is inadequately drained. In Autauga County it occurs in small areas which are sufficiently well drained to allow cultivation, except during seasons of excessive rainfall. The construction of a few small open ditches is usually all that is necessary to drain these areas thoroughly. The impervious nature of the subsoil, however, tends to check the free movement of soil moisture, and crops are likely to suffer both from excessive rainfall and from drought.

The Houston clay is formed from the disintegration of "rotten limestone"—Selma chalk formation of the Upper Cretaceous period, and is a highly calcareous soil, with a valuable special adaptation for alfalfa. Only a very limited acreage is under cultivation. The remainder is used mostly for grazing. Corn yields on an average from 10 to 20 bushels per acre, while the average for cotton is about one-half bale per acre. Johnson grass does well, yielding as high as 2 to 3 tons per acre. The fact that Bermuda and Johnson grass can be grown with success makes it a valuable soil for stock raising and dairying. No alfalfa is grown upon this soil in the county, but it has been demonstrated in other areas in Alabama and Mississippi that alfalfa can be grown with marked success wherever the drainage conditions are good. Melilotus also produces well.

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The type is held in conjunction with other soils in large tracts and has an average value of $5 to $15 an acre.

HOUSTON CHALK.

The Houston chalk is derived from the rotten limestone. The surface soil to depths ranging from 6 to 15 inches is a heavy dark-gray or brown loam or clay loam which becomes lighter in color a short distance below the surface. The subsoil is a dark gray to bluish gray or highly calcareous clay or rotten limestone, with a jointed or shaly structure. At various depths this grades into a mass of impure limestone.

Areas of this soil type are the result of erosion and the soil conditions vary with the severity of wash to which the material has been subjected. Included with the Houston chalk were patches of "red prairie" or Susquehanna clay, "black prairie" or Houston clay, and "yellow prairie" or Oktibbeha clay loam. These patches were too small to be separated and shown with their distinctive colors in the soil map.

The Houston chalk is deficient in organic matter and when wet is very sticky and difficult to handle. When thoroughly dry it crumbles readily and has the appearance of impure slaked lime. Where the soil has been protected from erosion it assumes something the character of the Houston clay.

Scattered about upon the surface and embedded in both soil and subsoil are phosphatic concretions, shells, and fossil impressions, all of which contain varying quantities of phosphoric acid as lime phosphate. Thin strata of greensand also occur at various depths.

The largest continuous body of this soil is found about 4½ miles southeast of Mulberry in the vicinity of House Bluff on the Alabama River. Areas of less extent occur in the vicinity of Kalmia, and along the bluff line of the Alabama River plains. Other outcrops occur about 5 miles southwest of Prattville.

The topography is generally hilly and broken and the surface is cut by many gullies. The drainage over most of the areas is excessive and erosion is severe where no means are employed to prevent it.

The greater portion of the Houston chalk is unused and valued chiefly for pasture. In some places sweet clover has obtained a stand and serves to protect the soil from washing. Where no attempt has been made to check erosion, the surface is usually devoid of vegetation. By filling up the deeper gullies with brush and seeding down the slopes with sweet clover erosion can eventually be checked to a large extent.

The Houston chalk type is probably best suited to dairying or stock raising. For general farming purposes it has very little value

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in its present state. In conjunction with other types of land it is valued at $5 to $15 an acre.

MEADOW.

The Meadow in Autauga County includes the low-lying, flat, poorly drained areas along the stream courses. In their present condition the areas are unsuited for farming. The materials forming the soil have been deposited during high-water time, and consist of wash from various soils on the uplands.

As it occurs along the smaller streams the soil is usually quite sandy and varies greatly in short distances. In some places it receives the washings from the red hills and retains the color for some distance along the stream courses. In other places the soil is dark brown to almost black. Along the largest streams where the water is sluggish during overflows the surface soil is usually a heavy loam or silt loam.

Along Little Mulberry, Swift, Autauga, Bridge, Indian, and Buck creeks the soils are somewhat more uniform. This is even more characteristic of the Little Mulberry and Swift Creek bottoms. The more elevated, better drained areas along these creeks consist of from 8 to 15 inches of a gray to brown sandy loam or light loam, resting upon a yellowish-gray to bright-yellow sandy clay, which below 24 to 30 inches changes to gray or is mottled. In some instances the soil could be cleared and cultivated without much extra drainage. It would be best adapted to corn and hay. In its present condition it makes excellent pasture during most of the year and is used almost exclusively for that purpose. Small patches of Muck are sometimes found associated with these bottoms. Where the large streams are dammed up for power purposes the backwater from these dams is responsible for the wet condition of a large percentage of the bottomland soils.

Small patches of sugar cane for home use are grown upon the better drained estuary deposits and washed-over areas of sand and light sandy loam which occur at the outer edges of the Meadow. This produces a sirup of light color and excellent quality.

The Meadow aside from its use for grazing is valued for the timber growth upon it, which consists of hickory, elm, oak, gum, and cypress.

SWAMP.

A comparatively limited area of Swamp, confined to the Alabama River plains, is found in the county. These areas are apparently the remains of former river channels which have become partially filled with sediments. In their present condition they have no agricultural value, and drainage would be very difficult and expensive.

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The largest body of Swamp occurs about 3 miles east of Autaugaville, and is known as Bear Swamp. A sluggish stream emptying into the Alabama River is its only drainage outlet. Other areas occur southwest of Prattville. Along the smaller streams a few areas of Swamp occur, but these were too small to be mapped and were included with Meadow.

The present value of Swamp depends upon the character of the timber, which consists of cypress, gum, bay, and other water-loving trees.

SUMMARY.

Autauga County (area 595 square miles) is located near the center of Alabama, and lies wholly within the Coastal Plain region. It is characterized by three distinct physiographic divisions; the flood plains, the Alabama River terraces, and the broken uplands. The drainage waters of the area eventually reach the Gulf of Mexico through the Alabama River.

The early settlers came largely from Georgia and the Carolinas, and the present white population is made up almost entirely of the descendants of these settlers. There is a large negro population, which forms the chief source of labor.

Prattville is the county seat and the largest town. Autaugaville, Billingsley, Vida, Spur, Jones, and Marbury are flourishing villages.

The Louisville and Nashville, Mobile and Ohio, Southern, and Alabama Central railroads and the Alabama River furnish transportation facilities to the principal markets, including Montgomery, Mobile, New Orleans, Birmingham, Selma, and points in the north.

The climate is moderate and is suited to a wide range of crops. The mean annual temperature is about 65° F., and the precipitation about 50 inches. The average growing season is from March 10 to November 8.

Including Swamp and Meadow, 22 soil types were mapped in the area. The Meadow is not under cultivation, but is used extensively for pasture. The Kalmia sand, sandy loam, and fine sandy loam, and Norfolk sandy loam and fine sandy loam are generally used for cotton and corn, but are naturally better adapted to trucking. Sumatra wrapper tobacco has been found in other areas to be especially adapted to the finer-textured soils of the Norfolk series with a sandy clay subsoil at a depth of 15 or 20 inches.

The Cahaba fine sandy loam and silt loam are best adapted to corn, cotton, and forage. The Myatt sandy loam is well adapted to cabbage, turnips, beets, corn, and hay, including Bermuda and Johnson grass. The Huntington loam is subject to frequent overflow, but when the seasons are favorable very large yields of corn are obtained.

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The Houston chalk, Houston clay, and Oktibbeha clay loam are residual soils derived from materials of Cretaceous age. The Houston chalk is badly eroded and has little present agricultural value. The Houston clay and Oktibbeha clay loam are suited to cotton and corn, and are well adapted to Bermuda and Johnson grass and alfalfa.

The Orangeburg clay, the Orangeburg sandy loam, and the Orangeburg fine sandy loam are better adapted to cotton than to corn. The sandy loam soils are also well suited to peaches. A fair grade of filler tobacco has been grown upon these soils in other areas. The Greenville sandy loam and fine sandy loam are best suited to cotton, but with proper management can be made to produce good yields of corn, oats, and forage crops. The Orangeburg sand, Norfolk loamy sand, and Guin gravelly sandy loam are rather light for general farming purposes, but are well adapted to peaches, grapes, and other fruits. The Orangeburg, Greenville, and Guin soils are derived from weathering of the pebbly loam, sands, and clays of the Lafayette formation.

Cotton is the chief money crop in the county. Corn is an important product, but none is grown for shipment. Oats, cowpeas, and peanuts are grown chiefly for forage. Truck crops, such as potatoes, cabbage, tomatoes, watermelons, cantaloupes, etc., are grown on a comparatively small scale, while some fruits are grown for the local markets.

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SOIL SURVEY OF COLBERT COUNTY, ALABAMA.

By WILLIAM G. SMITH, of the U. S. Department of Agriculture, and C. S. WALDROP, of the Alabama Department of Agriculture and Industries, assisted by J. C. BRITTON and C. R. ZAPPONE, Jr.

DESCRIPTION OF THE AREA.

Colbert County, Ala., lies in the northwestern corner of the State. The Alabama-Mississippi State line forms the western boundary, while Lauderdale, Lawrence, and Franklin counties bound it on the north, east, and south sides, respectively. In an east-and-west direction the county is 40 miles long, while in the widest portion north and south the distance is about 23 miles. Town Creek forms the eastern border and the Tennessee River the northern border, and the meandering of these streams gives the county an irregular outline. Within these boundaries there is comprised an area of about 384,000 acres, or 600 square miles.

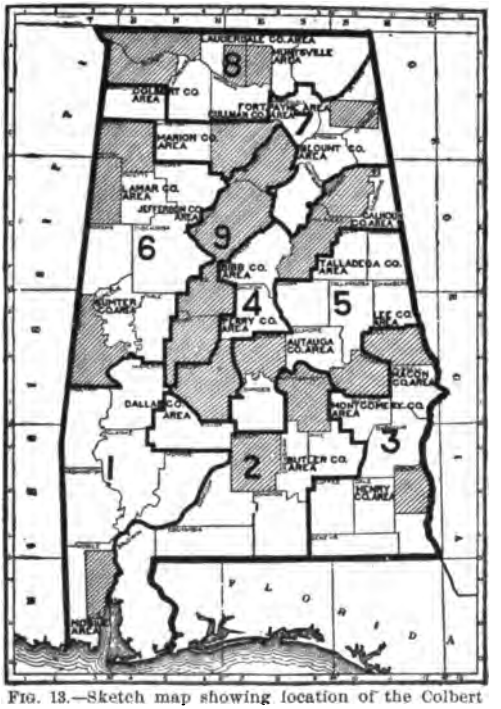

FIG. 13.—Sketch map showing location of the Colbert County area, Alabama.

A part of the northern portion of Colbert County lies in the Tennessee River valley region; the remainder of the county is in the mountain section. The valley section embraces level to gently rolling upland, with an elevation of 50 to 100 feet or more above the general level of the Tennessee River, while the mountain section includies lands 50 to 300 feet higher and characterized by rather broken topography made up for the most part of narrow ridges with steep slopes and narrow, deeply eroded stream valleys, with only occasional plateau-like areas. Practically

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all the drainage of the county is northward into the Tennessee River, which flows in a westerly direction along the north border of the county, and thence into the Ohio near its junction with the Mississippi River. Among the more important streams of the county are Big Bear River near the western boundary, Buzzard Roost Creek, Bear Creek, and Spring Creek in the central part, and Town Creek in the eastern part. Occasional points on these streams afford some water power and there is a possibility of developing a large amount of power in the vicinity of Muscle Shoals. None of the smaller streams, with the possible exception of Big Bear River and Town Creek, are navigable.

Colbert County was organized in 1867, having been cut off from Franklin County. The portion of the county comprised by range 9 was added, however, by act of legislature in 1895. According to the Twelfth Census the population of the county in 1900 was 22,341, of which 9,546 was colored.

The land included within Colbert County was sectionized about 1836, or shortly following the removal of the Cherokee Indians westward into Mississippi. Quite a number of white people had settled within this section a decade or more preceding the removal of the Indians, but after their removal settlers came in more rapidly from the older States. Many of the white inhabitants of the county are descendants of these early settlers.

The first land used for agriculture lay mostly in the valley section, practically all of which is now cleared and under cultivation. Over 60 per cent of this part of the county is owned in plantations containing from 400 to 2,000 acres. It is parceled out into 20 to 100 acre tracts to tenants, of which about an equal number are cash and share tenants. The proportion of the farms operated by white and colored farmers are about two of white to one colored. The white landowners of the valley section live mostly in and about the towns and villages, where many are engaged in business.

Only a small percentage of the mountain section has ever been cleared for farming, and most of it is still covered with the native forest of shortleaf pine, oak, and hickory. What few farms there are in this section are practically all operated by the owners, and the average size of the farms is about 160 acres. The greater proportion of the wild land is held by a few men in large tracts, reaching in one or two instances an acreage represented by five figures. The forested areas still contain considerable merchantable timber, though the sawmills and forest fires are rapidly depleting the supply.

The chief towns of the county are Tuscumbia, the county seat, with a population of about 5,000; Sheffield, the site of iron furnaces and railway shops, with a population of about 6,000; Leighton with

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about 800, Cherokee with about 500, and Riverton with about 200 inhabitants. Much of the country trading is done at these points, though no small amount is also done at stores located in the villages and at crossroads settlements.

The county is traversed near the central part, east and west, by the Southern Railway and north and south by the North Alabama Railway. Along these roads are many shipping points. A few of the wagon roads are macadamized. The majority of the roads, however, are dirt roads, those of the valley section being muddy in wet weather, while those of the mountain section are usually steep, stony, and badly eroded much of the time.

Farm products, mostly cotton and corn, are hauled to the different towns on the railways for shipment to large markets, such as Memphis, Chattanooga, Nashville, and Birmingham. There is a local demand at Tuscumbia and Sheffield for vegetables, poultry, and dairy products.

Water for domestic use is plentiful and of good quality. Many large springs occur in both the valley and the mountain sections. Some of these are highly mineralized, chiefly with sulphur and iron.

CLIMATE.

Colbert County lies within the limits of the warm temperate zone and is characterized by rather long, hot summers and alternating cold and warm spells during winter.

The average annual temperature is 61.2° F. The coldest months are December, January, and February, averaging about 42.5° F. Freezes, light snows, and cold rains of moderate duration occur during these months. July and August mark the hottest period of summer, averaging 78.5° F.

The average annual rainfall is 49.70 inches, the greater part of which falls during the winter and spring months.

The average date of last killing frost in spring is April 2 and of first killing frost in fall October 26, making a period of two hundred and seven days, or about seven months, during which tender vegetation may safely be grown. The winters, however, are open enough to allow growing such vegetables as turnips, cabbages, and onions, while the winter grains and certain grasses make some growth throughout the winter and give grazing practically all the year round.

Much farm work may be done during the winter time in the way of clearing land, plowing, constructing fences and buildings, and otherwise preparing for the more active period of the summer's work.

The tables following give the normal monthly and annual temperature and precipitation and dates of last and first killing frosts reported by the Weather Bureau station at Tuscumbia.

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Normal monthly and annual temperature and precipitation.

Month.	Tuscumbia.		Month.	Tuscumbia.	
	Temperature.	Precipitation.		Temperature.	Precipitation.
	°F.	Inches.		°F.	Inches.
January	40.2	4.92	August	78.2	3.50
February	43.5	4.78	September	70.0	2.97
March	52.7	6.80	October	62.0	2.10
April	62.0	5.18	November	52.9	3.34
May	71.0	3.00	December	43.8	4.38
June	79.6	4.30	Year	61.2	49.70
July	78.7	4.43			

Dates of first and last killing frosts at Tuscumbia

Year.	Last in spring.	First in fall.
1902	Mar. 19	Nov. 27
1904	Apr. 4	Oct. 27
1905	Apr. 17	Oct. 22
1906	Mar. 21	Oct. 11
1907	Apr. 14	Oct. 14
Average	Apr. 2	Oct. 26

AGRICULTURE.

The year 1836 marked the beginning of farming in this section. The valley lands were among the first opened up and the original forest growth of oak, hickory, and walnut was so rapidly removed that by 1860 most of these lands were cleared and in cultivation, and there were many large, prosperous plantations scattered throughout the valley section. The mountain section still retains much of the native forest growth, consisting of shortleaf pine, oak, and hickory. According to the Twelfth Census 46.1 per cent of the farm land in Colbert County is improved. The valley section makes up nearly all of this.

During the period preceding the civil war the Tennessee River afforded one of the means of travel and transportation, the cotton being hauled to the various landings for shipment. The completion of the railroad, now the Southern Railway, about 1850 greatly improved transportation. The conditions were made still better in 1883, when the North Alabama Railway was extended across the county from north to south.

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During the last few years considerable attention has been given to the study of better and more intensive methods of farming. Cotton and corn still continue to be the principal crops produced, with cotton in the lead. Rotation of crops is not commonly practiced, however, with the exception of occasionally alternating corn with cotton. When land begins to fall off in productiveness, it is allowed to lie idle a few years and to grow up in native grasses, after which it is again brought under cultivation for a time. If it so happens that Japan clover (lespedeza) forms a large part of the growth during this resting period, the soil is very much improved by reason of the addition of nitrogen and the accumulation of organic matter.

Commercial fertilizers are used to some extent on the uplands with greater or less degrees of profit, the bottom lands as a rule not seeming to need fertilizing, except in some cases where applications of kainit or mixed fertilizers high in potash have proved beneficial.

Two general methods of plowing and preparing the land for cotton and corn are followed, both of which have advantages under certain conditions. On the gently rolling areas the land is usually plowed during the winter or in the spring and subsequently harrowed and then bedded up in ridges 3 or 4 feet apart by throwing four furrows together with a turn plow, or by using a 4-disk cultivator. A large double-moldboard plow is also sometimes used for this purpose. The cotton seed is planted along the top of the ridges, usually by means of a 1-horse implement, which drops the seed and distributes the fertilizer in one operation. Some farmers consider it a little better to apply the fertilizer two or three weeks before planting the cotton, distributing it along the top of the rows and mixing it well with the soil. In this way the fertilizer becomes thoroughly incorporated with the soil before the young cotton plants have started. The use of the cotton planter, however, saves considerable labor and is popular for this reason. In the well-drained, level upland areas as well as in the rolling areas the method of handling the soil just described is highly recommended by many well-informed farmers. Some good farmers, however, favor the practice of level cultivation for such lands.

On the other hand, upon the low-lying areas and upon the steeper hillsides the farmers find it very desirable to ridge row the land without previously plowing the fields. In the former case the ridges are run so as to divert the drainage waters into some near-by channel; in the latter they follow the contours of the hill with a view to preventing erosion. The old practice of shallow plowing, turning up the soil to a depth of 3 or 4 inches only, still prevails, though the

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increased yields and better tilth resulting from deeper plowing have been realized by some.

Three to five cultivations are given cotton and corn during the first half of the growing period of the crops. For this purpose the small "Dixie" plow is much used, one man and one mule or horse being required to run it. A number of improved 2-horse cultivators are being used, and these have the advantage of cultivating a row at a time, thus very materially increasing the area covered in a day, besides leaving the soil in a much better condition. The 1-horse sweep, however, is often very effectively used. Shallow cultivation, frequent enough to keep down weeds and maintain a loose dirt mulch, is beginning to find many adherents, as opposed to the old practice of cultivation or plowing so deep as to injure the feeding roots of the growing crop.

The old practice of stripping the corn leaves (pulling fodder) before the ear corn is mature is very slowly giving way to the practice of cutting the whole corn plant about the stage when the ear corn is almost mature, but the leaves and stalks still quite green; then gathering this into small shocks.

The old practice of burning the corn and cotton stalks and other trash is being displaced to some extent. The better way is to turn all such organic matter under. An implement, the rolling-knife stalk-cutter, which breaks down the stalks and cuts them into small sections, makes it practicable to turn the stalks under with the plow. This practice tends to keep up the organic content of the soil and the resulting humus, a constituent which many of the cotton soils lack.

Cotton is the principal crop of the area and is grown in many cases almost to the exclusion of other crops, though this one-crop practice is gradually giving way to a more diversified farming, such as the growing of corn, small grain, forage crops, and vegetables. More attention is being given to raising hogs and other live stock for home consumption and marketing. It is well recognized that there are considerable areas of soil in the county upon which it is possible to carry on this diversified system of farming with profit.

Systematic crop rotation is not as yet much practiced in the county. The following three-year rotation, however, is used by some of the more progressive farmers and is strongly recommended as being well suited to the soils and climatic conditions of the area: First year cotton, second year corn, third year oats or other small grain. For this rotation it would be desirable for the three fields to be of nearly the same size, though of course this is not imperative. This rotation should be further amplified as follows: First year, cotton, followed by a seeding of a catch-crop mixture of vetch and rye just before the last cultivation of the cotton. This will not only furnish considerable pasturage during the winter months, but will also protect the field

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from leaching and washing; and besides, when the ground is plowed in the spring for the corn crop, considerable amounts of organic matter and nitrogen will be added to the soil. Second year, corn, followed by cowpeas sown at the last cultivation of the corn. This will likewise add to the organic and nitrogen supply of the soil. After the corn and cowpeas have been removed the field should be thoroughly prepared for the fall seeding of oats or wheat that follows next in the rotation. After the harvesting of the oats or wheat in the third year the ground should be immediately disked or plowed to a depth of 2 or 3 inches and sown to cowpeas. During the following winter the growth of grass and weeds is usually sufficient to furnish good pasturage. However, if better pasturage is desired the ground should be disked lightly in the fall and a catch crop of rye and vetch should be sown. Instead of sowing cowpeas after the wheat or oats some advocate the sowing of Japan clover in the young oats in the latter part of February. On removal of the oats, the young clover plants quickly thicken up in the oat stubble and by fall afford one or two cuttings of hay. If the second crop matures too late to be cut for hay, good winter grazing is afforded without any further effort on the part of the farmer. In the spring the land should be plowed and prepared for cotton if the above rotation is strictly observed.

By adopting this rotation the following advantages are secured, namely, the constant utilization of the land the year round for profit, the continuous addition of nitrogen as well as organic matter to the soil by growing catch crops largely of a leguminous nature, the destruction of many weeds and insect pests, and the retarding of erosion by winter cover crops. With its use the soil becomes more productive the longer it is cultivated instead of declining in yields, as is too often the case under the old methods of cultivation.

It has been found that commercial fertilizers are much more effective when used on soils already well supplied with organic matter; hence the above rotation plan is desirable even where fertilizers are to be used. An acre mixture for cotton on rather thin land which yields one-third to one-half bale per acre may be as follows: Two hundred pounds of high-grade acid phosphate, 200 pounds of cotton-seed meal, and 10 or 20 pounds of muriate of potash. A smaller quantity of this mixture may of course be used on an acre, but the 400-pound application is highly recommended by those who have tested the matter. After the land becomes more productive, giving three-fourths to 1 bale of cotton or more per acre, the following formula might be used: Three hundred pounds acid phosphate, 100 pounds cotton-seed meal, and the usual 10 or 20 pounds of muriate of potash. The nitrogen carrier is much reduced in this formula, this being admissible because the soil has become more highly charged with decaying organic matter. Various intermediate

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mixtures between these two formulas may of course be made up according to one's judgment of what the soil requires. For corn the formula varies some in the direction of larger proportion of cotton-seed meal. For the thin soil conditions noted above the acre mixture may be proportioned as follows: One hundred and fifty pounds acid phosphate, 250 pounds cotton-seed meal, and 6 to 10 pounds of muriate of potash. As the organic matter in the soil increases the formula may be changed, as follows: Two hundred and seventy-five pounds of acid phosphate, 125 pounds of cotton-seed meal, and the usual 6 to 10 pounds of muriate of potash.

For oats under similar soil conditions, a mixture of 125 pounds acid phosphate, 225 pounds cotton-seed meal, and 50 pounds muriate of potash is recommended as an acre application, the oats requiring a higher proportion of potash than either of the preceding crops. As the organic matter in the soil increases the cotton-seed meal may be reduced to something about as follows: Two hundred and fifty pounds acid phosphate, 100 pounds cotton-seed meal, and 50 or 60 pounds of muriate of potash. It is usually more practical to apply the fertilizer for oats or any small grain at the time of seeding, the grain drills usually having fertilizer distributer attachments that can be adjusted to let down the number of pounds per acre desired.

Nitrate of soda in some cases may be advantageously used as a top dressing on young cotton, corn, and small grain to the amount of say 30 to 100 pounds per acre, the larger amount where strong stimulation seems necessary. It may be applied in two or more applications, thus enabling the farmer to judge more accurately when enough has been used. An application of 100 pounds of nitrate of soda represents a cost of about $3.

The acre fertilizer formulas given above for cotton, corn, and oats represent a cost of $4 to $6 each, a smaller amount if home mixed. At best fertilizing is expensive, and this further emphasizes the idea that commercial fertilizers should be used conservatively and judiciously; that is to say, the right mixture and amount for each soil and crop should be sought after diligently.[a]

Not enough poultry and hogs are produced to supply the local demands. The price paid for these and dairy products suggests that there is room for an extension along these lines, both for local markets and shipping purposes. On the whole, it is believed more extensive live-stock raising would be practicable and profitable. The great native summer pasture grass is Bermuda, but Japan clover and crab grass also make good summer forage, while for winter pasture the

[a] For further information on fertilizers see Bull. No. 23, Ala. Dept. of Agr. and Ind.

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vetches, bur clover, and Texas bluegrass afford succulent feed through most of the winter. Notwithstanding the fact that local conditions appear so favorable for the production of plenty of good hay in the area itself, a great deal of baled hay is shipped in annually. Probably this will cease with the extension of diversified farming.

Vegetables of various sorts are easily grown almost the year round for home use and for the local markets, though there is some importation of these products, especially Irish potatoes. No doubt market gardeners could develop quite a profitable business supplying the local and outside markets. The growing of celery has been attempted upon the rich bottom lands near Cherokee. Fruit has never been produced except in a small way for local use. The mountain section of the county by reason of its elevation and good air drainage is recognized as being fairly well suited for the production of peaches and apples, and some fair-sized orchards are being set out.

Day labor is scarce, the iron works at Sheffield and the Government works incident to the construction of the 8-mile Colbert Shoals Canal on the northwestern edge of the county being partly responsible for the labor shortage during the last few years.

When labor is hired by the day the average wage is about 75 cents for ten hours' work. Ten to twenty dollars a month is the usual wage, with board in addition, for farm labor during six or seven months of the growing season. During cotton-picking time labor is usually more scarce, and the wage for picking varies from 50 cents to $1 per 100 pounds of seed cotton. Most of the tenants, however, rely on their families to do the picking.

According to the Twelfth Census about 63.6 per cent of the farms of the county are operated by tenants, cash and share rentals being about equally divided. An agreement in which the tenant must give 100 pounds of lint cotton per acre regardless of the acreage yield is sometimes entered into. Cash rentals vary from $2 to $5 an acre. There are two methods of share rentals practiced. One is where the owner, furnishing the land, necessary buildings, tools, work stock, and half the fertilizer, receives half the crop. The other, which seems to be in greater favor, is where the owner furnishes only the land and necessary buildings, while the tenant furnishes all the tools, work stock, labor, and fertilizers. In this case the rent is one-third of the corn and one-fourth of the lint cotton. Most of the tenants are found in the valley section.

The average size of farms in Colbert County, according to the Twelfth Census, is 93.6 acres, which is misleading, as each tenancy is classed as a "farm." The size of the majority of holdings ranges from 20 to 500 acres, while there are a good many tracts containing 1,000 to 5,000 acres, and in one or two cases from 20,000 to 40,000 acres, these latter being in the mountain section.

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The value of cleared farm land in the valley section of Colbert County ranges from about $10 to $25 an acre. In the mountain section land with the timber removed is valued at from $1 to $2 an acre, and with timber on it about $5 an acre, while improved farm land here may also bring $5 an acre. The very hilly, stony, and gravelly lands have but little value aside from the timber. The bottom lands, like the valley uplands, usually have a value of from $15 to $25 an acre, wherever not too often subject to overflow. In the mountain section a tract containing some bottom and considerable rough, hilly land with timber may have an apparently high value for farming purposes, since the bottom may easily be cultivated, while the hill land affords range for live stock.

SOILS.

The surface features of Colbert County fall naturally into two divisions—the valley section and the mountain section. The valley section is confined to the northern part of the area where it occupies approximately 40 per cent of the county, its southern boundary, which is approximately parallel to the Tennessee River, passing through Lagrange, Springvalley, Pride, and Cherokee. The topography of the valley is as a rule gently rolling, though there are some small areas where it is flat. Where gently rolling it is quite well drained, but the flat areas are usually in need of artificial drainage. The rock underlying the valley is mainly the St. Louis limestone, though in places along the edge of the mountain section the Bangor limestone appears and enters into the formation of the soils. Both of these formations are of Lower Carboniferous age.

With the exception of the bottom lands the valley soils are all residual, and consist mainly of clay loams and silt loams. They are the Decatur silt loam, the Abernathy silt loam, Clarksville loam, Colbert fine sandy loam, Clarksville stony loam, Leighton loam, Guthrie silt loam, Colbert silt loam, King clay loam, and King clay. The last three soils are derived from the Bangor formation; the rest from the St. Louis formation.

The topography of the mountain section varies from rolling to hilly, rough, and broken. The valleys are narrow and steep sided as a rule, while the divides are often much dissected and eroded. There are, however, occasional broad, plateaulike areas on some of the divides. The drainage is excellent, the area being crossed by many streams flowing northward into the Tennessee River. Many of the smaller streams and branches are swift running and have little or no bottom land along their courses. The rocks underlying the mountain section belong to the Coal Measures and are Carboniferous in age. They consist principally of alternating layers of sandstone and sandy shales. The aggregate thickness of these is hundreds of feet.

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The soils of the mountain section are of two classes, namely, those which are purely residual, being derived directly from the weathering of the underlying sandstones and shales; and those which are sedimentary, derived from the weathering of the unconsolidated material known as the Tuscaloosa formation, which during the Cretaceous period was deposited as a mantle over the sandstones and shales. The residual soils are the Dekalb silt loam and the Dekalb stony loam. The distinction between these two soil types is mainly one of topographic position, the former being found in limited patches upon plateaulike areas on the tops of divides, while the latter occurs in large areas upon the steep valley sides below or in any location where erosion has been specially active. To the sedimentary soils belong the Glenn loam and the Glenn gravelly loam. As in the case of the Dekalb types, the difference between the Glenn soils is due primarily to erosion, the loam areas being found on the plateaulike tops of ridges where erosion has been least, and the gravelly areas on the steep slopes where it has been especially active.

Throughout both the valley and mountain sections are found many areas of bottom land. The largest development occurs along Town Creek in the eastern part of the county and along Big Bear River in the western part. Besides these more important areas, many smaller bodies occur as strips of varying width along the minor streams. There are few farms that do not contain some bottom land, though in many cases owing to the narrowness of the strips it was not practicable to show them in the map accompanying this report.

The surface features of the bottoms vary from flat to slightly rolling. Most of them are subject to annual overflow. Along some of the larger streams there is an occasional high-lying area known as second bottom, which is somewhat more rolling than the rest of the bottom land and is not subject to overflow except during very high water in the streams. These bottom lands are alluvial in origin and each successive overflow brings fresh material from the uplands and deposits it upon the surface. The character of these deposits is often quite variable in short distances, but it is not possible to show these variations upon a map of the scale used in the survey. All of the bottom land in the county was mapped as one soil type, Huntington loam.

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The following table gives the names and areas of the several different types of soil mapped in Colbert County:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Dekalb stony loam	81,856	21.3	Leighton loam	5,440	1.4
Glenn gravelly loam	69,312	18.0	Guthrie silt loam	5,312	1.4
Decatur silt loam	55,872	14.5	King clay loam	3,136	.8
Huntington loam	37,440	9.8	King clay	1,408	.4
Clarksville loam	36,160	9.4	Colbert fine sandy loam	960	.3
Colbert silt loam	33,088	8.6	Abernathy silt loam	832	.2
Dekalb silt loam	26,368	6.9	Total	384,000	.....
Clarksville stony loam	19,712	5.1			
Glenn loam	7,104	1.9			

DECATUR SILT LOAM.

The Decatur silt loam, locally known as "red land," consists of a reddish to brownish silt loam with a depth varying from 6 to 10 inches, underlain to a depth of 3 feet or more by a reddish colored clay or silty clay. In spots the soil is inclined to contain considerable fine sand and in other places the sand is replaced by clay. The type is, however, easily cultivated and may usually be handled under a rather wide range of moisture conditions. Sometimes when the soil has been cropped so close as to reduce its organic content there is a tendency for it to run together and bake if handled when too wet.

The Decatur silt loam is confined to the valley section of the county, forming the greater part of the area east of Tuscumbia. The surface varies from level to gently rolling, the latter topography predominating. As a rule, the surface drainage is good and this, together with the mellow texture of the soil, makes the type an excellent one for general farming.

Residual in origin, the Decatur silt loam owes its formation to the weathering of the St. Louis limestone. It is possible that the material may have been modified to a slight extent by alluvial action during some remote geologic time.

The native forest consisted of oak, hickory, and walnut, which has been almost entirely removed. Under cultivation the soil is well adapted to all of the general farm crops of the region, including cotton, corn, and oats, besides such forage crops as Bermuda grass, Japan clover, and alfalfa.

Under the prevailing tenant system the average yield per acre of cotton is from one-half to three-fourths bale; corn, 20 to 40 bushels, and oats, 20 to 40 bushels. It is believed that double these yields could often be secured by better methods of cultivation. The fertilizer applications per acre recommended for the above crops upon this

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soil type are as follows: For cotton, a mixture of about 200 pounds of acid phosphate, the same quantity of cotton-seed meal, and from 10 to 20 pounds of muriate of potash; for corn about 250 pounds of acid phosphate, 150 pounds of cotton-seed meal, and 6 to 10 pounds of muriate of potash; for oats, 125 pounds of acid phosphate, 225 pounds of cotton-seed meal, and 50 pounds of muriate of potash. These applications, and especially the cotton-seed meal portion of the mixtures, may be greatly reduced as the soil is brought to a higher state of productiveness.

Fall plowing may be practiced if desired on the Decatur silt loam and the surface is level enough so that the fields may be allowed to stand throughout the winter without a cover crop and yet not suffer from erosion. The best practice, however, is to sow some such crop as hairy vetch, rye, or oats, which make good winter forage and enable the famer to carry more live stock.

Besides the staple crops, there are a number of special crops that may be grown to advantage. Cowpeas produce very well on this soil, and if fertilized at all require only about 300 pounds of acid phosphate and 20 or 25 pounds of muriate of potash to the acre. The cowpea is distinctly a hot-weather plant, matures in sixty or seventy days from time of planting, and serves very well as a catch crop in corn or for sowing on oat stubble. The Decatur silt loam is also suited to alfalfa, red clover, Japan clover, and the other clovers. Sweet potatoes, Irish potatoes, and other truck crops produce well, and small fruit, such as strawberries, can be grown to perfection.

The land of this type is as high priced as any in the area, ranging in value from $15 to $30 an acre.

The following table shows the results of mechanical analyses of typical samples of the Decatur silt loam.

Mechanical analyses of Decatur silt loam.

No.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19893	Soil	0 0	0.5	3.8	3.7	8.1	63.6	20.3
19894	Subsoil	.3	.7	.9	4.5	4.4	43.6	45.6

ABERNATHY SILT LOAM.

The soil of the Abernathy silt loam, which has a depth of 5 to 8 inches, consists of a reddish silt loam. Beneath this and extending to a depth of 36 inches or more occurs a subsoil of reddish heavy silt loam which in the lower depths changes from a solid to a mottled color.

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This type of soil occurs in a few small areas in the northeastern part of the county and is closely associated with the Decatur silt loam. It occupies depressions in the upland and is usually poorly drained. It owes its origin to surface wash from the surrounding higher lands. It contains a high percentage of organic matter, and where well drained produces excellent yields of corn and forage crops, as well as fairly good cotton. Most of the type is in cultivation. A top dressing of lime would doubtless make this type still more productive. Commercial fertilizer if used at all should have a rather lower cotton-seed meal content than indicated for use on the Decatur silt loam.

Of the forage crops Bermuda grass, Japan clover, Texas bluegrass, and sorghum produce well on this type.

The following table shows the texture of the soil and subsoil of the Abernathy silt loam:

Mechanical analyses of Abernathy silt loam.

No.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19891	Soil	0.2	0.6	0.8	5.5	5.2	70.2	17.2
19892	Subsoil	.4	1.6	1.8	10.4	10.9	55.0	20.0

CLARKSVILLE LOAM.

The Clarksville loam, locally known as "gray land," consists of a mellow gray loam with a depth of 6 or 8 inches, underlain to 36 inches or more by a subsoil of brown clay to silty clay which changes with depth to red. The texture and structure as well as the topographic features of this type are practically the same as those of the Decatur silt loam, the gray surface soil of the Clarksville loam being the feature distinguishing the two types. Within the areas of Clarksville loam there are often spots of red land which closely resemble the Decatur silt loam, but these are usually too small to be shown upon the map. The type is mellow and is easy to plow and cultivate.

Soil of this character is confined to the valleys of the Tennessee and Big Bear rivers and is best developed in the northeastern and northwestern corners of the county. The surface is level to gently rolling in character and the natural drainage is good. The soil owes its origin to the weathering of the St. Louis limestone. It is, as a rule, rather deficient in organic matter.

Originally this soil supported a forest growth of oak, hickory, and walnut, but this has been largely removed and most of the area is in cultivation. Cotton, corn, small grain, forage crops, and truck crops

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do well, though it is not considered quite as productive as the Decatur silt loam. The yield of cotton ranges from one-third to one-half bale per acre, corn 15 to 30 bushels, and oats 20 to 40 bushels per acre. Deeper plowing, rotation, and fertilization recommended for the Decatur silt loam applies equally well to this type.

Farms composed of this soil bring from $10 to $25 an acre, and are considered among the most desirable in the valley uplands. Better farm practices would soon put the soil in a much more productive state.

The following table gives the results of mechanical analyses of typical samples of soil and subsoil of the Clarksville loam:

Mechanical analyses of Clarksville loam.

No.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19877	Soil	0.0	0.7	2.9	24.0	14.3	44.7	13.5
19878	Subsoil	.3	1.4	1.4	13.5	11.0	43.8	28.5

COLBERT FINE SANDY LOAM.

The Colbert fine sandy loam consists of a gray, sometimes brownish, fine sandy loam 6 or 8 inches in depth, underlain to a depth of 36 inches by a red silty to fine sandy clay. In proximity to the Decatur silt loam the soil is inclined to be somewhat silty in texture and a little browner in color than in typical areas.

Only a very limited area of this soil occurs. One area containing about 1 square mile lies east of Springvalley and two other much smaller areas north of Mahama. The surface is level to gently rolling and the drainage is good. It is a residual type, probably derived from some fine-grained sandstone associated with the St. Louis or Bangor limestone formation.

The soil of this type makes very desirable farm land, being mellow and easy to cultivate and well adapted to growing the staple crops of the region. It is deficient in organic matter and the crop yields would be greatly increased by rotation of crops including some legume. Under the present system of farming the yield of cotton is about one-fourth to one-half bale per acre and of other crops in like proportion. Owing to its light texture, the soil is well adapted to the growing of truck crops.

The rotation and fertilizers suggested for the Decatur silt loam would be valuable in case of the Colbert fine sandy loam. Indeed, the necessity for adding organic matter to the Colbert fine sandy loam is, if anything, of greater importance. The keeping of more live stock, conserving the manure and applying it to the fields, preferably

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before the sowing of the winter forage or pasture crops, would also have a marked effect in increasing the yields of cotton and corn, besides giving much heavier yields of hay and better pasturage.

Land of this type of soil, like that of the other better valley lands, ranges in value from $15 to $25 an acre.

The following table gives the results of mechanical analyses of typical samples of the Colbert fine sandy loam:

Mechanical analyses of Colbert fine sandy loam.

No.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19875	Soil	0.1	4.4	17.1	40.7	3.5	14.8	18.7
19876	Subsoil	.0	.5	1.6	11.2	7.0	32.2	48.2

CLARKSVILLE STONY LOAM.

The Clarksville stony loam consists of 6 or 8 inches of a gray silt loam, underlain to a depth of 3 feet or more by a yellowish or reddish-brown silty clay. Disseminated through both soil and subsoil are found from 30 to 60 per cent of rounded gravel and angular quartz and cherty limestone fragments varying from one-half inch to 6 inches in diameter. The angular rock fragments are often so numerous as to interfere seriously with cultivation. In places, however, where these fragments are not too numerous the type is an easy one to plow and cultivate.

There is a considerable area of the Clarksville stony loam in Colbert County. It occurs in an almost unbroken strip in the northern part of the county, where it forms the bluffs and hollows along the Tennessee River. It is also found in a few small isolated ridges and knobs back in the valley. The natural drainage of the type is good.

The Clarksville stony loam is a residual type derived through weathering from the St. Louis limestone. Its stony character is due to an accumulation of the resistant quartz and cherty rock which were bedded in the massive limestone. Erosion has removed much of the other finer material and left these fragments strewn upon the surface and in the soil and subsoil. Along the Tennessee River the underlying massive limestone outcrops as bluffs from 20 to 100 feet high.

Originally the type was forested with oak, hickory, walnut, and some chestnut. The more stony and hilly areas are still forested, while the less stony and gently rolling areas are cleared and used for farming. Bermuda and Japan clover grow well. Cotton also produces well, averaging about one-half bale per acre. The yields of

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corn vary from 15 to 30 bushels per acre. The farmers believe that the stony nature of this soil makes it more retentive of moisture and better able to resist drought than the other upland soils of the valley. It is believed that deeper plowing, rotation of crops, more rational fertilization, such as suggested for Decatur silt loam, would very materially increase crop yields on this type. The value of this land varies from about $5 to $20 an acre.

The following table gives the results of mechanical analyses of fine-earth samples of the soil and subsoil of the Clarksville stony loam:

Mechanical analyses of Clarksville stony loam.

No.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19681	Soil	0.5	1.1	3.6	19.1	8.7	53.1	13.7
19682	Subsoil	.4	1.1	2.2	16.0	8.3	51.8	20.1

LEIGHTON LOAM.

The Leighton loam, locally known as "gray land," consists of a mellow, gray silty loam with a depth of 8 to 10 inches, underlain to a depth of 3 feet or more by a brown to yellowish-gray clay or silty clay. In places throughout both soil and subsoil iron concretions occur, and occasionally traces of small quartz gravel are found, though the presence of the latter is not a characteristic feature of the type.

Very limited areas of this soil occur in the valley of the Tennessee. It is best developed in the northeastern corner of the county. Over the greater proportion of the type the underdrainage is deficient, though where the surface features are gently rolling the natural drainage is good. It is a residual soil, derived through weathering from the underlying St. Louis limestone.

Forests of oak, hickory, and walnut, only small areas of which remain, at one time covered the areas of this soil. At present most of the type is cleared and in cultivation. It is an excellent soil for general farming. Cotton, corn, forage, and truck crops are grown. The yield of cotton ranges from about one-fourth to one-half bale per acre. Under a better cropping system, such as suggested for use on the Decatur silt loam, much better yields could be expected. This system would tend to add organic matter to the soil, a substance in which as a rule it is now lacking.

In value this soil compares favorably with other soils of the locality. Farms may be purchased for $10 to $25 an acre, depending upon the character of the improvements and the situation with respect to market and shipping points.

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The following table gives the results of mechanical analyses of samples of the soil and subsoil of the Leighton loam:

Mechanical analyses of Leighton loam.

No.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19917	Soil	0.8	2.1	1.6	10.8	14.0	51.3	19.2
19918	Subsoil	.0	.7	1.0	7.0	10.6	47.3	33.2

GUTHRIE SILT LOAM.

The surface soil of the Guthrie silt loam consists of 6 or 8 inches of gray to dark-gray, usually mottled, compact silty loam. It is underlain to a depth of 3 feet by a compact, rather impervious, grayish or mottled clay or silty clay. Both soil and subsoil contain varying quantities of iron concretions, the result of swampy conditions. It is a difficult type to plow and cultivate.

Areas of this soil are found in the valley section in the northeastern part of the county, where they occur mainly as small basinlike depressions from 5 to 10 feet below the level of the surrounding uplands. The surface is flat and the drainage is very poor. During winter rain water often stands in these depressions for long periods.

Most of the type is covered with oak, sweet gum, and an undergrowth of shrubbery and water grasses. Very little of it is under cultivation. Drainage is necessary before the soil can be used for farming. Under present conditions the areas should be allowed to remain in forests. Native grasses afford some pasturage.

The value of this land probably ranges from $2 to $10 an acre, though its mode of occurrence makes it rather difficult to determine its value.

The following table gives the results of mechanical analyses of the soil and subsoil of the Guthrie silt loam:

Mechanical analyses of Guthrie silt loam.

No.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent*	*Per cent.*	*Per cent.*
19913	Soil	0.2	0.9	0.4	1.4	2.1	68.3	26.0
19914	Subsoil	1.8	5.6	1.7	3.4	3.5	55.2	28.6

COLBERT SILT LOAM.

The surface soil of the Colbert silt loam, locally known as "gray land," consists of 6 or 8 inches of gray silty loam. The subsoil to a

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depth of 3 feet or more consists of a yellowish or grayish mottled clay or silty clay. The type is usually mellow and easy to cultivate.

Areas of this soil mark the southern boundary of the valley stretching from the eastern limits of the county, with only a few interruptions, to within 6 miles of the western boundary. The areas are from one-fourth to 2 miles wide and mark the dividing line between the valley and the mountain sections. The surface is gently rolling and the natural drainage good.

In origin the Colbert silt loam is residual, being derived principally from weathering of the Hartselle sandstone, influenced to a considerable extent by the decay of the associated Bangor limestone. These formations underlie the type at depths varying from 5 to 20 feet.

Like most of the other valley soils, this type in its virgin state supported a forest growth of oak, hickory, and walnut, and a considerable proportion of the area is still forested. The soil is usually considered rather unproductive, possibly the poorest of the valley soils. The effects of fertilizers are not very lasting, as the soil is inclined to be somewhat leachy. Under the present conditions cotton yields from one-fourth to one-half bale per acre, and other crops are correspondingly low. There is a marked deficiency in the organic content of the soil, and any system of farming that will supply humus will greatly increase the yield. There is no apparent reason why this should not be a fairly good soil for all the general farm crops.

The value of land of this type of soil ranges from $5 to $20 an acre, which is somewhat lower than the prices of some of the other gray lands of the valley section.

The following table gives the results of mechanical analyses of samples of soil and subsoil of the Colbert silt loam:

Mechanical analyses of Colbert silt loam.

No.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19887	Soil	0.7	2.6	1.5	9.1	19.9	54.1	11.2
19888	Subsoil	.2	.8	.5	3.6	9.2	49.8	35.7

KING CLAY LOAM.

The surface soil of the King clay loam consists of a gray clay loam of rather compact structure. The subsoil consists of a mottled gray clay which extends to a depth of 3 feet or more. This type is locally included within the general term "gray land." Owing to its somewhat compact structure it is a rather difficult soil to cultivate.

Small areas of this soil occur 4 miles south of Leighton. There are also two areas shown along the southern boundary of the county

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and a smaller area 2 miles south of Barton. The surface varies from flat to undulating. The areas are surrounded by higher lying land, and this topographic position results in poor natural drainage.

The King clay loam owes its origin principally to weathering of limestone, though in places it may have received some wash from the higher lying types surrounding it. The parent limestone is found at depths ranging from 3 to 10 feet below the surface. Like the other valley soils, this type was largely forested with hardwood species, including oak, hickory, and walnut, with some red cedar, a characteristic tree on this type. Much of the type is still in forest or in old fields which support a growth of grasses.

Where well drained the King clay loam is well adapted to cotton, corn, and forage crops. The undrained areas may better be left in forest. The crop practice suggested for the Decatur silt loam could be relied on to improve materially the productiveness of this soil, which is naturally low. The value of this type of soil ranges from $5 to $15 an acre.

The following table shows the average results of mechanical analyses of typical samples of the King clay loam:

Mechanical analyses of King clay loam.

No.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19921, 19923	Soil.	0.2	1.2	1.1	9.7	14.0	46.2	27.4
19922, 19924	Subsoil	.2	1.2	1.4	6.7	10.1	37.9	43.2

KING CLAY.

The King clay consists of a dark-gray to black sticky clay with a depth of 4 to 6 inches, underlain to a depth of 3 feet or more by a very sticky yellow to mottled-gray clay. There are usually present some limestone fragments in the surface soil. It is a rather difficult type to cultivate unless handled when in just the right moisture condition. Little of this soil is found in Colbert County. Small, scattered areas of it occur in the vicinity of Littleville, Pride, and Cherokee. The surface of the type is gently rolling, and the natural drainage is good.

The King clay owes its origin to the solution and decomposition of limestone, which usually is found beneath the soil in an unweathered state at depths of 3 to 10 feet. Red cedar is a characteristic tree on this soil, and the timber is exceedingly valuable at the present time.

Some of the type is cleared and in cultivation. Corn and alfalfa seem well suited to it. It is very retentive of moisture, and where

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rightly handled better corn yields are secured than from most of the other upland soils of the area.

Land of this type of soil ranges in value from $3 to $15 an acre.

The following table shows the results of mechanical analyses of samples of the soil and subsoil of the King clay:

Mechanical analyses of King clay.

No.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19925	Soil	0.0	4.1	2.7	8.3	3.0	34.9	47.0
19926	Subsoil	.4	2.4	2.4	8.2	5.1	24.1	57.1

DEKALB SILT LOAM.

The surface soil of the Dekalb silt loam consists of a gray silt loam which in places tends toward a fine sandy loam. The depth of this surface material averages about 6 inches. The subsoil is a yellowish-gray to brownish-red clay or silty clay extending to a depth of 3 feet or more. Like most clay subsoils, it is retentive of moisture, and this characteristic, together with the mellow, easily cultivated soil, places the type among the most desirable of the mountain soils.

This is not the most extensive soil of the mountain section, though it occupies a considerable portion of the southeastern part of the county. It has a surface varying from rolling to hilly. It is found on the plateaulike tops of the ridges and knobs that characterize the mountain topography, and in places it extends down some of the moderately steep slopes. By reason of its topographic position natural drainage is at times excessive, the crops suffering from drought sooner than on lower lying lands.

The Dekalb silt loam is a residual soil, derived from the weathering of a fine-grained gray sandstone of the Coal Measures. Only a small proportion of the type has ever been cleared and farmed, most of it being still forested with the original growth of oak, hickory, and shortleaf pine. The staple crops, cotton, corn, small grain, forage crops, and truck crops are grown, but the yields are usually rather low. Cotton yields from about one-third to one-half bale per acre, and other crops in like proportion. The type is very well adapted to Japan clover. By reason of its elevated position it is believed that there are considerable possibilities for orcharding. The organic content of the soil is naturally low, and the small yields are in part due to this deficiency. By following out the suggestions on crop practice outlined in the chapter on agriculture, it is believed that much higher yields and a higher quality of staple crops could be secured.

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Deeper plowing, say to a depth of 6 to 8 inches, is advisable, but it is not safe to practice broadcast plowing or to allow plowed land to lie uncovered during the winter, as may be done in the valley section, because of the tendency of the soil to wash and gully during the winter and spring months. The land should be broken in ridge rows run on contours around the slopes of the hills. In the steeper locations it is advisable to keep the land well terraced. Very steep hillsides, however, might better be left in forests or kept in permanent pasture than cultivated. Whenever the land is plowed in the fall some winter cover crop should be sown so as to minimize erosion.

The rotation which seems best suited to this type is as follows: First year, cotton, followed by a seeding of a mixture of vetch and rye just before the last cultivation of the cotton. This makes a cover crop that prevents washing and gullying during the winter months besides affording winter grazing, and with the cotton stalks furnishes additional organic matter for the soil. Second year, corn, in which cowpeas are sown as a catch crop either before or after the last cultivation of the corn. In the fall of the second year sow oats. These are harvested early in the third year, after which another crop of cowpeas should be sown. Next year return to cotton.

The fertilizer application per acre for cotton that best suits the present soil condition is as follows: 200 pounds of acid phosphate, 200 pounds of cotton-seed meal, and 10 or 20 pounds of muriate of potash. After the organic content increases and the soil becomes more productive the proportion of acid phosphate may be increased 2 or 3 parts to 1 of cotton-seed meal. For corn the acreage application recommended is 150 pounds of acid phosphate, 250 pounds cotton-seed meal, and 6 or 10 pounds of muriate of potash. After the land has been brought to a higher state of productiveness the proportion of acid phosphate can be increased to 2 or 3 parts to 1 of cotton-seed meal. For oats about 400 pounds per acre of a mixture composed of 125 pounds acid phosphate, 225 pounds cotton-seed meal, and 50 pounds of muriate of potash. The proportion of acid phosphate may be increased later, as in case of cotton and corn. Nitrate of soda as a top dressing on the growing crops in amounts of 30 to 100 pounds per acre may sometimes pay where the crop seems in need of quick stimulation.

The farms are small and usually operated by the owners. The value of land of this type ranges from $3 to $5 an acre.

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The following table gives the results of mechanical analyses of samples of the soil and subsoil of the Dekalb silt loam:

Mechanical analyses of Dekalb silt loam.

No.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19897	Soil	0.0	1.0	4.3	16.8	5.6	60.1	12.2
19898	Subsoil	.0	.8	2.1	11.4	4.1	49.9	31.7

DEKALB STONY LOAM.

This type consists of about 6 inches of gray silty or fine sandy loam, which is underlain to 3 feet or more by a yellowish, brownish, or reddish silty loam or heavy fine sandy loam. Sometimes, however, there are small areas which have a lighter textured subsoil. Scattered upon the surface and disseminated through both soil and subsoil are usually found numerous flat sandstone and occasionally some quartz and limestone fragments, varying in size from 1 to 20 inches in diameter. The rock fragments are so numerous as to interfere seriously with cultivation, and only an occasional area is suitable for farming. In places the soil covering has been entirely removed and the underlying rocks outcrop in massive walls along the steeper valleys.

The Dekalb stony loam occupies a large proportion of the mountain section, and is the predominating type in the southwestern part of the county. The surface of the type is rough and broken, being made up mostly of narrow stony ridges and steep valley slopes. The natural drainage is execssive and the soil is inclined to be droughty except where supplied with seepage water near the base of slopes.

Residual in origin, this type of soil has been derived through weathering from a fine-grained sandstone of the Coal Measures. Erosion has entered largely into the formation of the soil, the clay and silt having been washed away, leaving an accumulation of stones upon the surface. Most of the type is in forest, consisting of oak, hickory, and shortleaf pine, and the timber in many instances forms its chief value. The timber, however, is being rapidly removed.

Much of the type at present provides an excellent range for live stock, and there are many locations where the soil and climatic conditions are adapted to orcharding. The value of this land when cleared is about $1 an acre and when in forest about $5 an acre.

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The following table gives the results of mechanical analyses of fine-earth samples of the soil and subsoil of the Dekalb stony loam.

Mechanical analyses of Dekalb stony loam.

No.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19901	Soil	0.0	0.9	3.4	33.7	6.4	42.4	13.2
19902	Subsoil	.1	1.0	3.5	32.3	7.5	22.5	32.8

GLENN LOAM.

The surface soil of the Glenn loam consists of 6 to 8 inches of gray silty loam containing occasionally some small gravel. The subsoil to a depth of 3 feet or more is a yellowish or brownish silty clay, also containing in places some small gravel. The soil is easy to cultivate.

Areas of this soil occur throughout the gravelly hill section south and west of Cherokee. Three areas lie northwest of this place. The type is developed in the same topographic position as the Dekalb silt loam and bears the same relation to the gravelly member of the series as to the Dekalb stony loam. It is found on the tops of narrow ridges and in broader plateaulike ridges of the gravelly hills. The natural drainage is inclined to be excessive and the soil apt to be droughty.

The Glenn loam is derived from the weathering of the Tuscaloosa formation known in the earlier geological reports as "drift," which was deposited over rocks of the Coal Measures. This drift material represents the northern limit of the sedimentary deposits of the Gulf Coastal Plains.

Only a small portion of the type is under cultivation, the greater part being still in native forest of oak, hickory, and shortleaf pine. The soil is rather deficient in organic matter, a condition which is rather prevalent in the mountain section. When cleared, the usual crops of the region are grown. Cotton yields from one-fourth to one-half bale per acre, and moderate yields of corn are secured. By increasing the organic content of the soil and by adopting approved methods of crop rotation and fertilization it is believed that the type can be made a fairly productive one for the general crops of the region. The suggestions made in connection with Dekalb silt loam would apply to this type also. Besides being naturally adapted to forestry and range purposes, practically all of the type is adapted to orcharding. Land values of this type range from about $1 to $5 an acre.

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The following table gives the average results of mechanical analyses of samples of soil and subsoil of the Glenn loam:

Mechanical analyses of Glenn loam.

No.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19905, 19907	Soil	0.3	1.3	2.1	17.3	13.6	51.5	14.0
19906, 19908	Subsoil	.1	.5	1.2	15.9	13.9	35.2	33.1

GLENN GRAVELLY LOAM.

The Glenn gravelly loam consists of 6 to 8 inches of gray silty loam, underlain to a depth of 3 feet or more by a gray to reddish-brown silty clay. Both soil and subsoil contain from 30 to 60 per cent of well-rounded gravel varying from one-fourth inch to 2 inches in diameter. This soil is locally known as gravelly hill land. Where the proportion of gravel is large, the soil is difficult to cultivate.

A large part of the south-central, southwestern, and northwestern parts of the mountain section is made up of this type of soil. The surface is as a rule quite broken and hilly and the natural surface drainage is rather excessive. During a dry season crops are apt to suffer considerably from drought.

The type owes its origin to weathering of the Tuscaloosa formation. The material was a shore deposit at a time when what is now the Gulf of Mexico extended much farther northward.

Most of the type is now in native forest of oak, hickory, and shortleaf pine. The small areas under cultivation give low yields. As a whole it is naturally best adapted to forestry and as range for stock. It is believed that there are many parts well suited to orcharding. Japan clover is well established and furnishes considerable grazing in the areas where the timber has been removed.

If it should ever become necessary to use this type for the staple crops a cropping practice such as pointed out for the Glenn loam and Dekalb silt loam would also be applicable. It is believed, however, that the type should be devoted exclusively to systematic forestry. Land of this type cleared of its timber is valued at about $1 or less an acre and that in timber at about $5 an acre.

The following table gives the average results of mechanical analyses of fine-earth samples of the Glenn gravelly loam:

Mechanical analyses of Glenn gravelly loam.

No.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19909, 19911	Soil	2.9	4.3	3.8	18.1	10.9	46.4	13.5
19910, 19912	Subsoil	.6	1.7	2.6	13.1	9.7	44.7	27.6

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HUNTINGTON LOAM.

The surface soil of the Huntington loam consists of 6 to 8 inches of a mellow, brown to dark-brown, silty to fine sandy loam. The subsoil to a depth of 3 feet or more is a brown to gray loam or heavy silty loam. In places the subsoil tends toward the texture of a fine sandy clay. Along many of the smaller streams the soil is underlain at a depth of 4 to 6 feet by a bed of gravel.

Areas of the Huntington loam are distributed throughout the county, both in the valley and mountain sections. It occurs along the smaller streams and rivers and is more largely developed along Town Creek in the eastern part of the county and Big Bear River in the western part. This soil is of alluvial origin, the greater part of it being first bottom land with a level to slightly rolling surface and subject in most cases to annual overflow. Along these bottoms there are areas of low, flat, "crawfishy" land. The texture of the soil in these spots is a little heavier, and often after an overflow water stands upon them for several days. Along the bottoms of the larger streams there are sometimes higher lying terracelike areas, locally known as "second bottom." These are more rolling than the first bottom and usually more sandy in texture, sometimes gravelly, and seldom overflowed. The first terrace areas are being built up by each successive overflow, which brings fresh material from the uplands. Much of this is in the form of organic matter. The native vegetation consists of oak, sweet gum, poplar, alder, briers, some pine, with coarse swamp grasses and other water-loving plants. The lower bottoms are still largely in forest, but the more elevated, better drained areas are nearly all cleared and in cultivation.

The Huntington loam is an excellent soil for corn and forage crops, yielding from 20 to 40 bushels of corn with ordinary treatment, while under better cropping systems much larger yields are secured. Cotton produces quite well also, yielding one-half to three-fourths bale per acre with prevailing cultural methods, though much larger yields are possible.

On the higher lying portion of the type, comparatively free from overflow, oats produce well. As a rule a much larger proportion of the type is available for growing cotton, corn, and summer truck crops than is safe for winter crops, owing to danger from winter and early spring overflows. Bottoms rather subject to overflow, besides being useful for forest purposes, can be seeded to grass so as to afford excellent hay and pasture. Bermuda grass grows well, as do other native grasses. Texas bluegrass thrives on the higher bottoms. Japan clover seems to grow under quite a wide range of bottom land conditions, and, together with Bermuda grass, insures a cutting of hay or grazing throughout the summer.

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In cultivating cotton and corn upon this soil, neither crop should be grown continuously, but at least they should be alternated. The method of preparing the land recommended for the Decatur silt loam would be satisfactory for this type. Where the land is subject to frequent overflows, no winter cover crops should be sown.

Although the type is naturally fairly productive, crops seem to be benefited by applications of fertilizers. The following acreage application seems to approximate the average bottom land requirements: 200 pounds acid phosphate, 100 pounds kainit, and 100 pounds of cotton-seed meal. The same formula for corn might be used, but the following, with a higher proportion of cotton-seed meal, might be rather better to begin with: 150 pounds of acid phosphate, 150 pounds of cotton-seed meal, and 100 pounds of kainit. After the land becomes in good tilth and reasonably productive, a 300 or 400 pound per acre application of 10–4 goods might be used. If the land is sour, a top dressing of lime, say 1 to 1½ tons per acre, should be applied either before breaking or on the plowed ground before harrowing. If either cotton or corn look as if growth were being retarded, a top dressing of nitrate of soda in June or July, in one or two applications of not over 30 to 50 pounds per acre in each application, may be used to advantage.

The bottom lands are upon the whole among the most productive in the county, and are held in high esteem by the farmers. The value ranges from $15 to $25 or more an acre.

The following table gives the average results of mechanical analyses of samples of soil and subsoil of the Huntington loam:

Mechanical analyses of Huntington loam.

No.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19871, 19873.....	Soil.....	0.0	0.3	1.3	23.8	14.9	40.8	13.8
19872, 19874.....	Subsoil.....	.0	.1	.9	17.7	14.5	45.9	21.0

SUMMARY.

Colbert County, Ala., lies in the northwestern part of the State and comprises an area of about 384,000 acres, or 600 square miles. The surface features vary from level to gently rolling in the valley section to rough and hilly in the mountain section. The county was organized in 1867. Tuscumbia, the county seat, and Sheffield are the two important towns of the area. These towns are provided with good railway facilities.

The county is favored with a long growing season and short, mild winters, and an abundance of rain, fairly well distributed throughout the year.

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Cotton and corn are the chief crops. Oats are sown for pasture or for hay, but are seldom thrashed.

Bermuda grass and Japan clover constitute the principal hay and pasture grasses. These are supplemented by cowpeas and sorghum. Alfalfa, burr clover, and Texas bluegrass are also used for hay and pasturage. A few peaches and apples are grown, and truck farming is engaged in to some extent to supply the local demands. It is believed that there are considerable opportunities for developing both the fruit and the trucking industries. As a rule no definite crop rotation is followed.

Usually the live stock is of rather inferior grade, but recently there has been considerable improvement along these lines.

The "Dixie" plow is still largely used, though larger turn plows, 2-horse cultivators, and other improved machinery are coming into use. Terracing, contour ditching, and level ridge rows for hilly lands are common practices.

The valley farms are largely operated by tenants, while the mountain farms are more often operated by the owners.

Farm land has increased in value considerably during the last decade. The valley lands now range from $10 to $25 an acre, the mountain lands from $1 to $5 or more, according to stand of timber, and the bottom lands from $15 to $25 an acre.

Fifteen soil types occur in the county. Nine of these are limestone soils and one of mixed origin in the valley section. Four soils occur in the mountain section, two derived from sandstone and two from unconsolidated deposits. One soil occupies the river and stream bottoms in both sections of the valley.

The Decatur silt loam is the most extensive soil of the valley section. It is held in large tracts, but most of it is farmed, being leased to tenants in 20 to 100 acre plots. It is naturally a strong soil. Cotton and corn are the chief crops, though it is also adapted to small grain, cowpeas, clover, Bermuda grass, and alfalfa.

The Abernathy silt loam, limited in extent, occupies basinlike and elongated depressions. The surface is flat and poorly drained. When drained, it is an excellent soil for corn and forage crops. The type is naturally a strong soil and much of it is in cultivation.

The Clarksville loam is an important valley soil. Most of it is in cultivation. Cotton and corn are the crops usually grown. It is also well adapted to small grain and to grasses and other forage crops.

The Colbert fine sandy loam is limited in extent, but is an important valley type. It has a gently rolling surface, is easily cultivated, and is adapted to a wide range of crops.

The Clarksville stony loam occurs along the bluffs of the Tennessee River, and its surface varies from gently rolling to very hilly. The

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more level and less stony portions of the type produce good yields of cotton, corn, grain, grass, and forage crops. The stonier areas are forested and afford some pasturage.

The Leighton loam is a type of limited extent. Its surface features vary from level or depressed to gently rolling. It is practically all cleared and in cultivation to cotton, corn, small grain, grass, and forage crops. It is also used to some extent for trucking.

The Guthrie silt loam occurs in small areas in the northeastern part of the valley section. It is poorly drained, and the water often stands upon the surface during a wet season. Drainage is necessary before the soil can be cultivated.

The Colbert silt loam, quite an extensive type, occurs along the southern limit of the valley section. Its surface is gently rolling. About half of the type is in cultivation, the remainder being still in native forest. The staple crops, including truck crops, are grown, but as a rule low yields are secured.

The King clay loam is of limited extent. It occurs as small areas somewhat depressed and lower than the surrounding types. Its surface is flat or very slightly rolling and the drainage is very poor. In its present condition it is not well suited to farming. It should be kept in forest and used as a range for live stock.

The King clay is also of limited extent, occurring in small areas near the base of the foothills of the mountain section. It is locally known as black clay or black lime land. Its surface varies from level to rolling. Only a small part of the type is in cultivation. It is an excellent soil for corn and alfalfa, and grasses and other forage crops produce well.

The Dekalb silt loam occupies the tops of ridges, small plateaulike areas, and some of the slopes in the mountain section. It is of sandstone origin and not naturally productive. Only a small percentage is in cultivation. It is mostly in forest. Cotton and corn are grown with only moderate success. Small grain, truck, grass, and other forage crops may also be grown. From its location the type should be fairly well adapted to peaches and apples.

The Dekalb stony loam is an extensive type in the mountain section. Practically none of it is under cultivation. It is best adapted to forestry, live-stock range, and in places to orcharding.

The Glenn loam occurs in small areas in the mountain section. Its surface varies from level to quite rolling. It is derived from the Tuscaloosa formation and is not naturally productive. Only a small percentage of it is in cultivation, mainly to cotton and corn. It is probably a fair type for tree fruits.

The Glenn gravelly loam is an extensive type in the mountain section. Its surface is very rough and broken, consisting of narrow

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ridges, knobs, and steep slopes. The type is derived from the Tuscaloosa formation. Only small areas are in cultivation. It is best suited to forestry and as range for live stock. The better areas could be used for fruit.

The Huntington loam is the bottom-land type in all parts of the county. Much of it is subject to overflow. It is a very productive soil and is practically all in cultivation. It is especially well adapted to corn, though cotton, oats, and forage crops do well.

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SOIL SURVEY OF CULLMAN COUNTY, ALABAMA.

By W. E. THARP, of the U. S. Department of Agriculture, and W. L. LETT, of the Alabama Department of Agriculture and Industries.

DESCRIPTION OF THE AREA.

Cullman County is located in the north-central part of the State of Alabama. The meridian of longitude 87° west of Greenwich and parallel of latitude 34° north intersect about 2 miles west of Bremen, a small village situated in the southwestern corner of the county. On the north it is bounded by Morgan and Marshall counties; on the east by Marshall and Blount; on the south by Blount and Walker; and on the west by Walker, Winston, and Lawrence. The county is in shape a right triangle and contains 474,230 acres or 741 square miles.

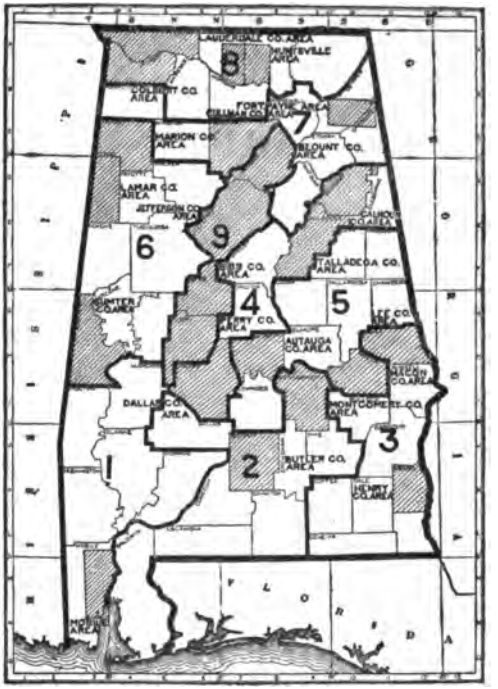

FIG. 14.—Sketch map showing location of the Cullman County area, Alabama.

The base map used in this survey was redrawn from a county map, which omitted many of the details of drainage and recent culture. Many corrections were made, but it is not nearly so complete in this respect as is desired. About 75 square miles on the Warrior River was covered by a topographic sheet.

The general surface inclination of most of the area is toward the south and the drainage is into the Warrior River. About 30 square miles along the northern border is tributary to the Tennessee River. The divide between the two drainage systems is a comparatively narrow ridge which lies, for the most part, 1 or 2 miles south of the northern boundary. The highest points within the area, usually about 1,100 feet, are found along this divide. The ravines and gorges which form the heads of the north-flowing streams are very deep and narrow, but widen rapidly toward the lowlands of the Tennessee

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Valley. In many places near the county line the plateau, or "mountain," as it is locally termed, abruptly terminates in steep declivities, with numerous outcrops of massive sandstone. On the south the surface slope is more gradual and the branches usually rise in rather shallow depressions, or as they unite lie between hillsides of moderate grade. Near the northwest corner of the county, however, there is considerable broken land south of the narrow watershed.

The largest stream wholly within the county is Ryan Creek. It rises a few miles northwest of Cullman and flows west of south and joins Sipsey River near the southwest corner of the county. Crooked Creek, which is 6 or 8 miles farther west, has about the same trend. It leaves the area near the middle of the western boundary. Blevens Creek and a few other small branches drain the northwestern portion of the county. The lower course of each of these streams is a rocky gorge. From a few miles below Trimble to its junction with the Sipsey River, Ryan Creek has many bluffs from 50 to 100 feet in sheer ascent from the water, with steep slopes above leading back to the comparatively level "mountain" top.

The south-central townships are drained by Dorsey, Sullivan, and Marriott creeks. Broglen and Duck creeks receive much of the drainage of the eastern half of the area, while the numerous short tributaries of the Warrior River drain the remainder.

The creeks in the eastern half of the county flow through rather narrow valleys, but in general the land near them is less broken than that along the streams in the western part of the county. Throughout the northeastern townships the main divides are broad and their surfaces undulating to moderately hilly. The relief, of course, becomes more pronounced near the streams and in many instances rather short, steep-sided ravines cut back into the fields. In other cases, however, the extremities of the drainage lines are shallow depressions, which form very desirable farm land.

As a rule the divides between the streams west of Ryan Creek are not so wide as those just described. The deeper valleys of the main streams give the tributaries high gradients, so that the latter in many instances have cut well back toward the middle of the dividing ridges. Therefore a relatively larger proportion of the surface is hilly and broken. In this section there are, near some of the creeks, occasional areas of bench land, ranging in extent from a few acres to 1 or 2 square miles, intermediate in elevation between the uplands and the stream channels. A good example of the larger of these topographic forms is the depression to the north and west of the high ridge on which Jones Chapel is located.

The southwestern part of the area is a spur of the table-land lying between Dorsey Creek and lower Ryan Creek. The margin is rough and broken, but much of the central portion is excellent arable land.

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The top of Arkadelphia Mountain is also comparatively level. The surface of each of these elevations ranges between 700 and 800 feet above sea level. Stouts Mountain is another remnant of the table-land left in high relief between the deep valleys of Marriott and Thacker creeks.

The country between the last-mentioned elevations and Warrior River lies several hundred feet lower and the topography is more varied. Many rounded ridges and knobs occur, with occasional nearly level areas that owe their outlines and surface features to a horizontal strata of hard sandstone which resists weathering and erosion much more effectively than the softer shales. The small streams in this section are usually bordered by strips of alluvial soil. Limited deposits of this nature are found on the inner curves of the Warrior River and there are also a few terraces which afford small areas of fine farming land.

It is probable that the first settlements within the present county limits were made near Arkadelphia, about seventy years ago. Emigrants from the counties to the east located in the little valleys north of the Warrior River and for many years their farms were small and the agricultural methods and general style of living remained very simple. Few if any slaves were owned by these people. On the "mountain," as the remainder of the area was called, there were a very few settlers prior to 1870. These depended for a living quite as much upon hunting as they did upon the cultivation of their small clearings. Some owned cattle and hogs, which ranged the woods the year around—a method of stock raising which prevailed until very recent years.

In 1872 the South and North Alabama Railroad, now a part of the Louisville and Nashville Railroad, was completed across the county. The company building this road received from the National Government each odd-numbered section of unpatented land on either side for 15 miles.

In 1873, John Cullman, for whom the county was subsequently named, brought a few German families from Cincinnati to this area and founded the town of Cullman. Some also came direct from Germany and located in and near Cullman. In the following years he and a number of men, cooperating with the railroad company, were very successful in securing settlers from the more northern States.

In the early eighties people from the northwestern part of Georgia, attracted by the cheap lands, moved into this area. Many others followed, and when all the Government land suitable for farming had been homesteaded, the later settlers purchased direct from one of the several land companies, which had acquired title to or were agents for large holdings of the orginal railroad grant. This immigration still continues. The Georgians are from the farming class of their own State, and as a rule are accustomed to farming in a timbered country.

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Clearing the land is a rather slow process, although the stumps of the shortleaf pine, oak, and hickory, which form most of the virgin growth, rot in a few years after the timber is felled or deadened.

Individual holdings seldom exceed 160 acres; in many instances only 40 acres. The improvements usually consist of a one-story frame house, well, and a small barn and outbuildings. The fields are unfenced, stock not being allowed to run at large.

The middle portion of the county is the most thickly settled, and the general character of the improvements is good. Near Cullman there are many well-improved farms.

With the possible exception of a rather narrow belt along the railroad, it is evident from the general appearance that the country is in the earlier stages of its agricultural development. This is especially true of the extreme eastern and western townships. Portions of the latter are thinly settled and there is much desirable farming land yet uncleared.

Cullman, the county seat, with a population of about 3,000, is the principal distributing and shipping point for the county. Besides ordinary commercial interests centered there, it contains a number of factories. The State Odd Fellows' Home for Orphans, St. Bernard's College, and the County Agricultural High School are located near this town.

The country roads radiating from Cullman are good. Most of the streams are bridged and considerable outlay has been made in reducing the grades. Many new roads have been laid out in recent years. All except the most thinly settled sections have rural delivery of mails, and a number of telephone lines cross the county.

CLIMATE.

Since there is no Weather Bureau station in Cullman County, the following table has been compiled from records kept at Decatur and at Oneonto. The former is situated on the Tennessee River, about 30 miles north of Cullman, the latter in Blount County, about 25 miles southeast of the center of Cullman County.

Normal monthly, seasonal, and annual temperature and precipitation at Decatur.

Month.	Temperature.			Precipitation.			
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year.	Total amount for the wettest year.	Snow, average depth.
	°F.	°F.	°F.	Inches.	Inches.	Inches.	Inches.
December	42	72	0	3.8	2.0	5.5	Trace.
January	42	77	−3	5.9	6.5	5.6	0.2
February	44	77	−12	5.4	1.1	5.3	1.5
Winter	43	.....	.....	15.1	9.6	16.4	1.7

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Normal monthly, seasonal, and annual temperature and precipitation at Decatur—Continued.

Month.	Temperature.			Precipitation.			
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year.	Total amount for the wettest year.	Snow, average depth.
	°F.	°F.	°F.	Inches.	Inches.	Inches.	Inches.
March	53	84	4	6.4	3.9	4.2	.5
April	62	92	26	4.6	3.6	11.1	.0
May	69	98	37	3.5	1.3	2.7	.0
Spring	61			14.5	8.8	18.0	.5
June	78	106	47	3.4	1.6	2.8	.0
July	81	107	56	4.5	5.2	7.5	.0
August	80	104	53	3.4	3.2	6.4	.0
Summer	80			11.3	10.0	16.7	.0
September	72	99	37	2.8	3.6	5.0	.0
October	61	93	33	2.1	4.7	.3	.0
November	50	80	15	3.7	3.4	5.0	Trace.
Fall	61			8.6	11.7	10.9	Trace.
Year	61	107	−12	49.5	40.1	62.0	2.2

Normal monthly, seasonal, and annual temperature and precipitation at Oneonto.

Month.	Temperature.			Precipitation.			
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year.	Total amount for the wettest year.	Snow, average depth.
	°F.	°F.	°F.	Inches.	Inches.	Inches.	Inches.
December	43	70	1	4.3	0.6	10.2	Trace.
January	43	73	9	5.2	1.8	6.8	Trace.
February	42	71	−15	6.4	4.8	4.3	1.7
Winter	43			15.9	7.2	21.3	1.7
March	54	81	4	6.5	6.9	8.7	Trace.
April	60	92	24	4.9	3.1	5.5	.0
May	70	94	38	4.8	4.6	8.0	.0
Spring	61			16.2	14.6	22.2	Trace.
June	76	97	45	4.6	4.4	3.2	.0
July	78	103	53	6.2	9.5	4.2	.0
August	78	101	50	4.1	2.8	7.4	.0
Summer	77			14.9	16.7	14.8	.0
September	73	99	34	2.1	1.1	4.2	.0
October	61	90	26	2.2	.8	.7	Trace.
November	50	79	11	2.4	4.3	2.0	Trace.
Fall	61			6.7	6.2	6.9	Trace.
Year	61	103	−15	53.7	44.7	65.2	1.7

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In general the climate in summer is agreeably tempered by the elevation, and there are not many days in which field labor can not be carried on without discomfort. The nights are rather cool.

In winter the ground occasionally freezes to a depth of several inches, but does not remain in this condition longer than a few days. There is considerable cloudy weather during this season. Most of the precipitation is in the form of light rains, which last for a period of several days. Between these rainy periods the weather is mild and pleasant. A few light snowfalls usually occur each winter.

The growing season for most crops may be said to extend from March to November. Fall-sown rye, oats, vetch, and turnips remain green most of the winter. The growth of these grains, as well as of some of the grasses, is suspended only for the brief periods in which unusually severe weather prevails.

The date of the last killing frost in the spring is generally in the first half of April. In the fall rather heavy frosts may be expected before the last of October. On the higher elevations fruit trees in blossom escape injury when serious damage is done on the level land and in the valleys.

AGRICULTURE.

Two general types of agriculture prevail in this county. In the vicinity of Cullman and southwest along the railroad a considerable variety of field crops is grown on the majority of the farms, and there is also much attention given to certain lines of trucking. In all of the townships which are not so conveniently located with regard to the railway, almost the entire acreage of cleared land is annually planted to cotton and corn. This difference in the methods of farming is not altogether due to the better market facilities of the former locality as compared with the latter, but is due in large measure to a marked distinction in the agricultural habits of the people who occupy the respective locations.

Most of the Germans and other people from the north settled near the railroad. They introduced new crops and put into practice methods of farming which were practically unknown to their southern neighbors. It is almost unnecessary to add that the general adjustment to local conditions has resulted in the abandonment of some crops and the modification of the methods of raising those which were found profitable. But the infusion of new ideas has given a diversity to the agricultural productions of this section which could not otherwise have been attained in the same length of time.

As previously stated the eastern and western townships are largely occupied by people who recently came from Georgia. They are familiar with the cultivation of cotton, but, as a rule, are not accus-

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tomed to growing grain (except corn), grass, and other products for the markets, nor have they had much experience in stock raising. In most instances all the cleared land on each farm is planted to cotton and corn. The former is the money crop and usually represents almost the entire income of the year. The latter is mostly consumed by the work stock, but a little is fed to the few hogs which are butchered for home use. The farmers whose means are limited or who are making the first payment on their land must necessarily depend upon cotton, which is a safe crop and gives immediate returns. It is also the basis of credit with the local merchants. There are many farmers, however, who could adopt a more diversified type of farming if they so desired, but who persistently follow cotton growing to the exclusion of other crops.

According to the county assessor's returns for 1908, approximately 107,206 acres of land are now under cultivation. More than half of this is devoted to cotton. In the eastern and western townships the cotton acreage is relatively higher than in the middle part of the county. The production for 1908 was about 21,000 bales, the general average for the county being reduced by dry weather in August.

Corn is next to cotton in importance, but since practically all is consumed on the farms, it is only indirectly a source of profit.

Sweet potatoes are an important crop. In 1908 7,750 barrels were shipped from Cullman. The net price received was about $1.50 a barrel. The quality is excellent and considerable attention is given to the production of those varieties adapted to particular markets. The Jersey sweets are preferred by buyers in the northern cities, while the larger and softer Dooly yams meet the demands of the southern markets. Although the prices vary considerably from year to year the crop is a profitable one. The yield ranges from 100 to 200 bushels per acre, and second crops such as winter oats and rye may be planted on the ground after the potatoes are dug.

In 1908 50 carloads of strawberries were shipped from Cullman. The production is steadily increasing and represents the aggregate yields of a large number of small producers. Many farmers have a few acres planted, but there are practically no large fields devoted to this fruit. The soil and climatic conditions favor the production of those varieties having a fine flavor and possessing good shipping qualities. Cullman berries have an enviable reputation in Detroit and also in other northern cities where they are becoming known.

Raspberries and grapes are successfully grown. The cultivation of the latter was introduced by the Germans, and formerly considerable wine was made. The industry has since declined and the vineyards have been generally neglected.

Some very fine apples, pears, and peaches are grown. Some careful growers have secured highly profitable returns from small apple

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and pear orchards. In size, color, and flavor the fruit compares favorably with that from the better-known fruit-growing sections of other States. A good many people who have attempted fruit culture have met with very poor success. In many instances locations unsuited for orchards were selected and varieties were chosen from various other localities without regard to their probable adaptation to conditions existing in the area.

It does not seem reasonable that varieties of fruit originating upon or found well adapted to the heavy soils of the limestone valleys or the cherty ridges occurring in the Appalachian Mountains should find the Dekalb soils altogether congenial. With regard to soil adaptations preference should be given to trees from regions where the Dekalb and associated series prevail. In many instances peach trees are obtained from the comparatively heavy soils of the Piedmont region and planted on the lighter phases of the Dekalb fine sandy loam. It has been found in this area that peach trees generally thrive best on the highest ridges of Hanceville loam, and the red phases of the Dekalb occasionally occurring in elevated situations. This is due in part to the better air drainage and freedom from frosts, but it may also indicate the superior adaptability of this red land to the particular requirements of certain varieties.

In all cases the higher ridges of the Dekalb fine sandy loam are to be preferred to the comparatively level soils of the same type or to the loam. Since damage to the bloom often occurs in the spring and is the chief cause of crop failure, it seems probable that certain northern slopes of the Dekalb stony loam should afford favorable sites for orchards. The location should be high, as compared with the land for some distance to the north, and all the timber in the immediate vicinity should be removed, except on the crest of the hill to the south. This belt of forest would tend to retard the warming of the soil on the slope below, which is the chief desideratum in the selection of such a site for an orchard. The small orchards on the farms generally receive some cultivation, but the necessity of spraying, pruning, and thinning is given little consideration.

In the culture of cotton and corn, commercial fertilizer is generally used. In most brands cotton-seed meal usually furnishes the nitrogen. A high percentage of acid phosphate is preferred by most farmers. It is generally conceded that all these soils respond to potash, and most crops are benefited by its application. Some high-grade fertilizers carrying considerable nitrate of soda are used by strawberry growers.

The Dekalb soils are very deficient in humus. In any plan of fertilization the increase of the vegetable matter should be given first consideration. A larger amount should be returned to the soil than is obtained by the use of cowpeas alone. The manner in which the

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latter are usually grown supplies nitrogen to the soil, but does not materially raise the content of humus. If the latter were liberally increased the physical condition of the soil would not only be improved, but the presence of humic acids would render available more of the mineral constituents—potash and phosphates—and also increase the efficiency of the mineral fertilizers artificially applied. This principle should not be overlooked in considering the fertilizer requirements of the types generally under cultivation.

The Dekalb soils are also deficient in lime. In the few instances where it has been used good results have followed. This mineral should be used in connection with applications of manure, or when green crops are plowed under. Where immediate results are not required and a permanent improvement of the soil is desired applications of finely ground untreated phosphate rock would be beneficial. Both lime and phosphoric acid would be obtained, and if a rotation of crops were adapted calculated to keep up the humus content the nitrogen supply would take care of itself. The present practice of planting cowpeas between the rows of corn or sowing them broadcast in open fields is to be commended, but in most cases the tops of the plants are removed and a rather small proportion ever finds its way back to the soil in the form of manure. The nitrogen rendered available by the peas stimulates a better growth in the succeeding crops, which also makes heavier demands upon mineral constituents. If practically the entire crop is removed from the land, as is the present practice with regard to corn, and in many cases with other crops, no permanent improvement of the soil results. On the contrary, there is a decided tendency to impoverish it. The Dekalb soils do not have the depth, and, judging from their geological origin, do not possess the degree of permanent fertility which is found in valley lands or those soils derived from a greater variety of rocks. The ease with which the Dekalb fine sandy loam and the Dekalb loam may be kept in fine physical condition, combined with the favorable climate, insures crop yields, notwithstanding the poor cultivation often given and the generally low humus content. The indefinite maintenance of their productivity, however, demands less exhaustive methods than now prevail on most of the corn and cotton farms.

For most crops each of the above-mentioned types should be plowed deep and the lighter phases of the Dekalb fine sandy loam should be stirred deep enough to mix the silty material of the subsoil with the relatively sandy surface soil. This gives a soil of good physical composition and absorptive capacity. Practically all the types, with exception of the Dekalb stony loam and a part of the Huntington silt loam, are capable of absorbing and holding enough moisture under proper management to carry a crop over any of the dry periods

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which occur in the growing season. Cultivated crops should be given frequent shallow cultivations.

On much of the cultivated land near Cullman winter rye and oats are grown. The same kind of cover crops should be more generally sowed in the cotton-growing sections. A practicable rotation for most farms would include fall-sown oats or rye, with vetch or clover, followed by cowpeas sown broadcast. The third year corn or cotton should be planted.

Bermuda grass and Japan clover do well on all types except the lightest phases of the Dekalb fine sandy loam. Where the ground has been cleared and cultivated for a few years both of these crops will establish themselves if given an opportunity to do so. The clover appears along the roadsides and in all old fields in settled sections of the area. The Bermuda grass may be easily planted by dropping pieces of the sod in newly plowed land, and, since it spreads by runners, it soon covers the ground and forms a dense sod. The grass makes a vigorous growth from six to eight months of the year. It is relished by all stock and it seems a conservative estimate to state that 1 acre will support a cow for six months of the year. The small pasture lots found on a few farms are overgrazed—mules, cattle, and hogs all being allowed to run in the inclosure at all seasons.

These valuable plants used in permanent pastures may be made the basis of a system of farm management which would include stock raising. Green winter feed may be cheaply obtained by raising winter oats, rye, and vetch, all of which do well, and cowpeas, soy beans, and sorghum will each produce very heavy yields, even on poor land. Thus a succession of forage crops can be had during the greater part of the year. More hogs should be raised, as cowpeas, peanuts, and chufas or peas and some corn can be cheaply supplied for feed from the farm. All of these crops, as well as others, are grown, but their use in the manner and for the purpose indicated is very rare. This plan necessitates considerable fencing on each farm, the erection of better buildings, and also requires the personal attention of the owner. It has much to commend it, especially to those farmers who are located a considerable distance from markets and who have a considerable proportion of their land cleared.

The present demand for pork is largely supplied from the packing houses in the northern cities. Approximately 1,000,000 pounds of ham, bacon, and side meat are annually retailed in Cullman, much of it being sold on credit to farmers, who in turn practically obligate themselves to produce cotton.

The present farming population of the county numbers about 18,000, with perhaps 3,000 more in the towns and villages. The total number of live stock, approximately 7,000 cattle, the same num-

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ber of swine of varying ages, and about 800 sheep, is decidedly too low considering the number and size of farms. In many instances recent settlers have very little of the land cleared, but on the older farms from one-third to three-fourths may be given as a rough estimate of the average acreage under cultivation.

According to the assessors' returns for 1908, the value of all lands, including improvements, is $2,340,200, which represents about 40 per cent of the actual value. The increase in value of late years has been rapid in all parts of the county. Near the railroad improved farms have more than doubled in value in five years. Uncleared land is also held at a higher price than prevailed a few years ago. Many farms are mortgaged for a considerable part of the value, especially in the newer sections, and rather high rates of interest prevail.

There are very few tenant farmers in this area. So long as present conditions obtain there will be very few large estates of cultivated land operated by renters or hired laborers. With the exception of a few families near Hanceville, there are no negroes in the county. There is no class of people here from which very many farm laborers can be drawn. The Germans and most of the Georgians and native Alabamians are essentially home makers and prefer the ownership of even a small farm to any form of renting or leasing.

As a larger proportion of the area is being brought under cultivation the general trend of agriculture is toward the production of crops other than cotton and corn. The discouraging experiments that marked the early attempts at truck raising are gradually giving place to the profitable culture of potatoes, strawberries, and other crops. This is due in some measure to the cooperation of the growers in marketing their products, and is also the result of experience. The German Farmers Shippers' Association handles much of the truck business. Most of this produce goes to northern cities, but Birmingham and the mining towns near it also afford a good market. There is a strong demand for poultry, dairy products, and good live stock of all kinds.

SOILS.

With regard to their origin and geological relationship the soils of this area are comparatively simple. They are residual, being derived directly from the underlying sandstones and shales. Very limited areas of alluvial soils are found in the southern part of the county, but the material composing them has, in the main, been transported such short distances and suffered such a slight degree of change that mineralogically these sedimentary soils do not differ greatly from those which are strictly residual.

Throughout this part of the Cumberland Plateau the superficial strata consist of nearly horizontal beds of sandstone and shale of

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Carboniferous age. In some of the deepest gorges on the north line of the county limestone is exposed, but it has contributed nothing to the soils, except in the immediate vicinity of the few outcrops. No metamorphic or crystalline rocks were found at any point in the area surveyed.

In general, in the eastern and northern portions of the county, the upper beds of sandstone, or those most frequently exposed by the minor inequalities of the surface, range in thickness from a few inches to several feet. The interbedded shales and occasional layers of clay usually exceed in their total thickness the aggregate mass of the sandstone. The basal members, as shown in the deeper stream gorges, consist largely of massive sandstones with relatively thin beds of shaly rock.

Most of this sandstone is fine grained, rarely coarse textured, and only occasionally contains any quartz gravel. Mica flakes are noticeable and the iron content is high enough to give quite pronounced brown-red tints where disintegration has begun. Pieces soft enough to be crushed in the hand are found to consist largely of rather angular, iron-stained quartz grains of appreciable size, but there is also more or less silt and a little clay present.

A very common phase, observable in road cuts, is a heavy bedded grayish sandstone which, as it yields to the agencies of dissolution that act beneath the soil cover, assumes a red color to a depth of a foot or two, and becomes so friable that it is easily broken by a light blow from a hammer. This decaying portion, and also the pieces of rock included in the subsoil proper, absorb water so readily that they contribute to the moisture holding properties of the soil mass.

In a few instances the stratum immediately below the subsoil is hard and slaty and interferes with the subdrainage. The same effect occasionally results from the presence of a rather heavy layer of clay or highly argillaceous shale forming the lower subsoil. As a rule the sandstone is more or less seamed and fissured and the shaly material is so varied in composition and structure that no impervious zone is found near enough to the surface to affect the soil.

The softer strata lying between the sandstone beds range from thin red and brown layers, which consist chiefly of very fine sand cemented with iron oxide, to light-colored clayey shales. The latter are usually thin layers that in many instances are beds of white unctuous clay a foot or two in thickness. Some of the lower members of the shale beds are slightly carbonaceous but none of them are calcareous.

On all of the table-land the weathered residue of the surface rocks forms a soil body ranging in thickness from a few inches on the steepest slopes to several yards on the comparatively level areas. The surface inequalities have caused sufficient creep and wash of the upper portion of this material to commingle pretty thoroughly the

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particles from all sources. To this agency is due, in large measure, the rather limited range in texture of the soils, silty loams and fine sandy loams predominating in all parts of the area. While there are not very great differences in the mineralogical character of the superficial formations, the heaviest shales and coarsest sandstones would give quite diverse soils if the weathered products of each remained in place.

In the south-central townships very heavy beds of true shales constitute most of the country rock. They are generally highly argillaceous, are dull green, gray, and occasionally purplish in color, and weather to reddish-yellow clay. They are found from the stream channels almost to the tops of the table-land and the highest hills. The elevation of much of this region is lower than that of the plateau to the north. This, as well as the more varied topography which it presents, is due to the readiness with which the shales yield to erosion. The steep flanks of the mountains are usually strewn with rock from the sandstone capping the summits. Frequently the soil contains considerable sand from the same source, but at a slight depth the soil of the slopes consists chiefly of weathered shale, usually a stiff clay. The characteristic shale topography consists of rounded ridges and knolls. In such areas the soil mantle is thin and the surface usually carries more or less débris from the harder portions of the rock.

The occurrence of comparatively thin beds of sandstone in the heavy deposits of shale has given rise to the bench lands and some of the flat-topped elevations found near Warrior River and its tributaries in this region. Such topographic forms are rather conspicuous features and usually the soil on them is derived almost entirely from the sandstone.

All of the residual soils have been correlated with the Dekalb series. This series has a wide distribution in the northeastern part of the State, where sandstones and shales of the Coal Measures have extensive exposures. The horizontal position of the Carboniferous strata of this area has given soils superior in agricultural value to most of those derived from similar rocks which have been more disturbed. Not only does this soil mantle have a greater average depth, but it has not lost through excessive erosion such a large proportion of the finest constituents, as occurs in somewhat similar regions of comparatively high relief.

In a few places a soil derived from a hard reddish-brown sandstone has an unusually high percentage of clay and is characterized by the deep-red color of the subsoil. While the rock associated with this type, and from which it is derived, contains a higher percentage of iron than the average of the sandstone in this region, this factor does not satisfactorily account for the high degree of fertility which

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this soil maintains after many years of cropping. It has been correlated as the Hanceville loam.

The limited alluvial deposits on the streams in the southern part of the area consist chiefly of weathered material of local origin. Owing to the high gradients the deposition has been confined chiefly to the comparatively coarse materials. Much of the latter is a fine sand and therefore fine sandy loams predominate along the Warrior River and most of the smaller creeks. The alluvium of the former evidently contains but little débris from the limestone outcrops in Blount County. Along the small streams, which have no territory tributary to them except shale land, the alluvial soils are generally silt loams.

The better-drained soils of the above character have been correlated with the Huntington series. It is probable that in their general minerological composition they are inferior to some soils of this series derived from a greater variety of rocks. The physical structure, however, is good. The present agricultural value depends largely upon local drainage and the artificial increase of the humus content.

Two local types, besides considerable areas of Rough stony land, also occur in the southern part of the area.

All of the area was originally covered with a rather open forest of shortleaf pine and deciduous trees, oaks and hickories predominating. Such a vegetal covering is not conducive to the accumulation of humus, most of the organic matter oxidizing upon the surface instead of becoming incorporated in the soil. It was also customary from the earliest occupancy of the adjoining region by white settlers to burn over the mountains to improve the pasturage and facilitate the hunting of deer and turkey.

The name and the actual and relative extent of each of the types mapped is given in the following table:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Dekalb fine sandy loam	172,800	36.2	Huntington fine sandy loam	3,072	0.7
Dekalb loam	131,200	27.7	Hanceville loam	2,752	.6
Dekalb stony loam	78,848	16.7	Holston fine sandy loam	1,152	.2
Dekalb shale loam	59,712	12.6			
Rough stony land	18,816	4.0	Total	474,240	.....
Huntington silt loam	5,888	1.3			

DEKALB STONY LOAM.

The distinguishing features of the Dekalb stony loam are the rough topography, stony surface, and variable depth or thickness of the soil section.

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The soil is usually a fine sandy loam, 10 or 15 inches deep, containing considerable silt and but little clay. The first few inches of virgin soil is very friable and loamy, dark gray in color, and open in structure. The latter quality is due in part to the included gravel and small stones as well as to the high content of vegetable material. Below this surface loam the material is a slightly coherent silty fine sandy loam, gray-brown or sometimes slightly reddish-brown in color. In cultivated fields the vegetable matter rapidly disappears and the soil assumes a gray or gray-brown color, and is generally covered with sandstone fragments. Washes and gullies are frequently a feature of hillside fields, for the soil yields readily to erosion.

The subsoil is a reddish loam or fine sandy loam more compact and retentive of moisture than the soil. In most instances it contains sandstone fragments of various sizes and in all stages of disintegration. The lower subsoil consists chiefly of the more resistant fragments of sandstone, with interstitial material derived in part from the slope above. Frequently the subsoil rests directly upon a soft, pink or reddish rock which is the disintegrating portion of the massive gray sandstone common to this region.

When relatively thick beds of shale occur, the subsoil contains a higher percentage of clay. On the slopes in such localities the weathered edges of successive members of the shale beds form the subsoil. These may range from arenaceous layers to highly argillaceous strata, with an occasional trace of carbonaceous material. Necessarily the subsoil may vary considerably within short distances. Differences which might greatly affect the water-holding capacity on level land are offset by the high surface gradient and consequent thorough drainage. Occasionally these shale phases are traceable by the native vegetation, the hickories and poplars preferring such situations, while oaks are more commonly abundant on the soil overlying sand rock.

As a rule the soil over the shales does not differ greatly from that above the sandstone. The creep and wash of surface débris on the slopes has usually resulted in a pretty thorough mixing of all the loose materials. This is the case on the long steep hillsides bordering the larger streams.

In general there is a very easy gradation along the crests of the hilltops between the upland types and the Dekalb stony loam. The latter may have but little stony material upon the surface. Farther down the slope rock débris, flat sandstone, bits of shale, and gravel are more in evidence in the soil, while the subsoil partakes of the nature of the strata immediately below it. Near the stream channel heavy ledges of rock are usually exposed.

In the southwestern part of the area no close line can be drawn between this and the Rough stony land. Near Warrior River and on

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Mariott and Sullivan creeks, small areas of fine sandy loam which are comparatively level, but thickly strewn with hard gray sandstone fragments, some of which are a foot or two across, have been included in this type. A few areas of bench land with very stony surfaces are found. They are locally termed "post-oak flats."

Probably less than 2 per cent of the type is cleared. Most of it is covered with a mixed growth of pine, oak, and hickory. Black gum, poplar, and sycamore occur, but are not abundant. Much of the best timber has been removed and the present covering is mostly a second growth. Sourwood, cucumber, holly, bay, haw, and other shrubs form part of the undergrowth, with sedge grass in the open places. There is a little wild cane remaining along the streams, but in general this land does not furnish much pasture.

A large proportion of this type should remain timbered. At the present rate at which the more desirable Dekalb fine sandy loam and Dekalb loam are being brought under cultivation, the time is not far distant when this and the Rough stony land will be the only forested land in the county. Fires do much damage to the young trees, but public sentiment against unlawful firing of the woods is increasing, and this, coupled with the results of the stock law, tends to preserve the present growth of young timber.

The cheapness of most of this land, $4 to $10 an acre, tempts many men of limited means to purchase a 40 or 80 acre tract and clear the best portion. In many instances, however, the results are unsatisfactory. The soil washes so easily that it can not be maintained in a condition of tilth suitable for corn or cotton. Sowed crops could be more easily managed. When cleared land of this type forms part of a farm it could be utilized to good advantage as permanent pasture for Bermuda grass and Japan clover. On some hillsides, where the relative elevation gives good air drainage, desirable locations for orchards may be found. Those phases which have a red or reddish-yellow subsoil are to be preferred for fruit to those which are lighter colored.

The following table gives the average results of mechanical analyses of fine-earth samples of Dekalb stony loam:

Mechanical analyses of Dekalb stony loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
20203, 20205	Soil	0.7	1.2	8.5	36.7	15.2	29.5	8.1
20204, 20206	Subsoil	.8	2.2	6.7	38.8	15.4	27.9	8.1

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DEKALB SHALE LOAM.

The soil of the Dekalb shale loam to a depth of 5 or 6 inches is a friable silty loam. It usually contains a small amount of fine sand and a variable amount of clay. The proportion of the latter increases with depth. The first 2 or 3 inches of virgin soil consist chiefly of fine sand and silt and considerable organic matter, with just enough clay to give it a low degree of coherency. Below 6 inches the material is quite heavy, and when saturated it is plastic and somewhat adhesive. In old fields the surface has a tendency to be slippery, if wet, but this is modified by the abundance of shale fragments. The color is light yellowish clay tending to reddish brown. In many instances the shale fragments and brown ferruginous gravel are very abundant, determining to a considerable extent the surface color.

The subsoil is a reddish clay or clay loam, heavier and more compact with increase of depth. It generally has a coarsely granular structure which is due in part to the high clay content, and also to the angular form of the bits of included shale. As the latter disintegrates it generally assumes roughly cubical forms.

The lower subsoil is generally a rather compact mass of highly argillaceous shales. The thin horizontal layers are crossed by innumerable vertical and oblique seams, but the material as a whole is almost impervious. Excepting the portion which has suffered considerable disintegration it is not a ready absorbent of water, and therefore unfavorably affects the moisture conditions in the upper soil where it is shallow. Artificial exposures usually consist of angular fragments ranging in size from a fraction of an inch to several inches across. The clayey layers are generally dull gray to greenish purple, while those which include more very fine sand weather to brown and yellowish tints. The latter evidently contain more iron and are also a little more open in their general structure. Carbonaceous strata are occasionally seen but no calcareous layers are found near the surface.

As a rule, all of these shales weather to a heavy silty clay, which has a decided tendency to assume a red or reddish-yellow color. The depth of the weathered residue seldom exceeds 3 or 4 feet, while on the steep slopes it is much less. In nearly all old fields the surface of the knolls and sharp ridges is covered with yellow-brown pieces of shale, and in each little gully weathered shale in place may be seen beneath the shallow covering of reddish clay.

In depressions and where the surface has less inclination the soil has a great depth. In such places it usually contains considerable fine sand, and the percentage of silt is higher than in the strictly residual material.

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The semialluvial soils along the minor drainage lines, seldom more than a few acres in one body, are brown, silty loams, very fertile and easily tilled if the drainage is good.

Most of this type is found in the south-central townships, and the topography is more varied than that of the higher table-land to the north and west. Besides the sandstone-capped hills previously mentioned, there are many shale ridges too rough to be of much agricultural value. The lower slopes often spread out into relatively level areas of good farming land.

The valleys near Arkadelphia and the one in which Bremen is located are general depressions between the outlying spurs of the plateau. Excepting the narrow strip of alluvium along the creeks, the surface consists chiefly of low ridges and knolls with moderate slopes. The depth of the soil mass at any point depends chiefly upon the topographic position. In the depressions it may be several feet deep, but on the slopes it is generally very shallow.

Owing to the light character of the first few inches of the soil and the close, heavy structure of the subsoil, this type erodes badly. Some old fields that formerly produced good crops of cotton, corn, and wheat are now abandoned, and many of the steepest hillsides are practically beyond redemption.

In the depressions and on the comparatively level bench lands the yields of cotton range from one-third to 1 bale per acre. Corn, which is usually given the advantage of location, produces from 10 to 25 bushels. Where the soil is shallow it is particularly susceptible to drought, so that no very close estimates of crop yields can be made. In favorable situations the soil is frequently found to be very loamy and easily cultivated, with a deep clay-loam subsoil which is especially retentive of moisture. Such phases are well adapted to a wide range of crops and the yields are good.

Bermuda grass and Japan clover do well on all phases where the native vegitation has been removed. Redtop thrives well on the low ground and it is probable that by the application of lime clover could be established on many of the warm hillsides. It would be necessary to prepare a good seed bed and sow with a nurse crop of oats or rye. Much of this type, which at present gives very poor returns when planted to cotton, could be profitably used as pasture.

The native vegetation consists chiefly of deciduous trees—hickory, poplar, and several varieties of oak being most numerous. The uncleared ridges and steep hills should remain forested.

The valuation ranges from a few dollars an acre for the roughest land to $12 or $15 for that under cultivation. Some of it is underlain by coal, but this is not considered in the above estimate.

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The average results of mechanical analyses of representative samples of the soil and subsoil are given in the following table:

Mechanical analyses of Dekalb shale loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19260, 20208, 20210.	Soil.....	1.9	2.5	1.2	6.0	10.1	58.7	19.6
19261, 20209, 20211.	Subsoil.....	.8	2.1	.8	2.9	9.7	42.0	41.5

DEKALB FINE SANDY LOAM.

The soil of the Dekalb fine sandy loam, to a depth of about 12 inches, is a light-colored fine sandy loam. In many instances as much as 40 per cent of the material consists of the finer grades of sand. The silt content is moderately high and generally there is but little clay present. The soil for the first few inches is very friable, and in many places where more than the average amount of medium sand is present it is quite loose. Its structure is often rendered more open by the presence of a good deal of ferruginous gravel, but there is very little coarse sand found anywhere. Areas in which the gravel is unusually abundant have been indicated on the map by the gravel symbol. When dry the soil is yellowish gray to buff, but when moist it is light brown, becoming yellowish brown with increase of depth.

No very definite line can be drawn between the soil and subsoil. The latter contains a much higher percentage of clay than the former. It is therefore heavier and more compact. The upper portion is generally a yellowish clay loam, with little or no coarse material except a few small gravel. The clay content increases to a depth of 3 or 4 feet, and the lower part of the subsoil is usually a reddish-brown heavy clay loam. It is a little more granular in structure than the upper portion, plastic, and somewhat adhesive when wet, and under usual field conditions it is compact, but not impervious. When exposed in gullies and washes the red surface bakes very hard, but when turned up by a plow and subjected to tillage this material is rather crumbly. It is not so friable as the soil, but by no means is it difficult to reduce to a fine state of tilth.

The basal portion of the subsoil varies in character with the nature of the underlying rock. Where the latter is a sandstone there is usually a stratum, 2 or 3 feet thick, between it and the subsoil proper, which consists of disintegrated rock fragments in a matrix of sandy material much more open than the subsoil. In many places the clay loam rests directly upon the soft reddish surface of the sandstone,

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with but a few inches of decayed rock between. In all cases, however, there is good underdrainage.

Where the subsoil rests upon shaly rock with thin layers of clay alternating with the harder material the gradation from clay loam to unweathered rock is more gradual. The transition is generally a friable silty or clayey loam with layers of the more resistant strata intact, but all are more or less affected by oxidation and range in color from light buff to bright red.

A phase of this type, which is distinguished by the reddish color of the subsoil, and usually by a brownish tint of the soil where the latter has suffered some surface washing, is found in many places. These departures from the type are commonly found on the hills near the large streams, and vary in size from a fraction of an acre to rather ill-defined areas of several hundred acres in extent. These red spots are heavier in texture than the average, and therefore require a little more labor to keep in good tilth. They are usually considered of better quality than the light-gray land.

The Dekalb fine sandy loam is the prevailing type in the western part of the county. It has an extensive development on the "mountains" in the northwestern part of the area, where it is derived entirely from a heavy gray standstone. In the eastern townships it is generally confined to the more hilly or rolling sections along the streams. The native vegetation consists chiefly of shortleaf pine and several varieties of oak.

The soil is very deficient in humus, and even in virgin woodland the dark-colored surface loam seldom exceeds a few inches in depth. The friability and consequent ease of tilth which marks this type is due principally to the texture and relative proportion of the mineral constituents. A very slight increase in the content of vegetable matter, however, makes a great improvement and renders the soil much better adapted to grain crops.

This type being easily cultivated and well drained, is admirably adapted to a great variety of truck crops. Its present use in this respect, however, is limited by the opportunity for the profitable disposal of such products, and also by the indisposition of most of the owners of this kind of land to engage in such business. Sweet potatoes, strawberries, raspberries, and grapes are most successfully grown. In gardens many varieties of small fruits and vegetables are easily grown, and the results indicate that the soil under proper management is highly productive. Of course liberal fertilization is necessary, barnyard manure alone giving excellent results.

The greater part of the type under cultivation is devoted to cotton. As a rule it does not produce a very large plant, but the quality and yield are good. The latter averages about 1 bale per

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acre where thorough tillage is given. Commercial fertilizers are commonly used. The quantity applied is usually less than 200 pounds per acre, very frequently much less. No very definite statement regarding the results from the use of the various combinations of potash and phosphoric acid can be made. They usually give an increase in yield, but the first requirement of this type, as already stated, is humus. A very marked increase in growth of both cotton and corn always follows any increase in the vegetable content. The yield of corn ranges from 10 to 15 bushels per acre. On new land the yield is much better, 25 to 30 bushels being secured.

The type is fairly adapted to all the field crops grown in this section of the State. Local differences due to slope, elevation, or to an unusually high percentage of sand in the soil must of course be taken into consideration. In some instances the depth and nature of the subsoil should be given attention. For most truck and small-fruit crops it is to be preferred to the Dekalb loam, while for grains and grasses the latter is to be preferred because of its texture and moisture-holding capacity.

The advantage which either type may possess in adaptation to particular crops may be offset by difference in cultivation. While the normal phases of the Dekalb loam are more retentive of moisture than the average of the fine sandy loam, the latter is frequently found to withstand drought better. This is generally due to the methods of tillage. When both types are deficient in humus and rather infrequent shallow cultivation is given, the fine sandy loam will maintain a comparatively loose surface mulch unfavorable to evaporation, while the loam becomes more compact and loses moisture rapidly. If the latter were managed with a view to conserving moisture, it would give the better results, except in cases where the fine sandy loam has an unusually deep and heavy subsoil.

Improved land located within a few miles of the railroad is worth from $15 to $20 an acre. Uncleared land may be bought much cheaper. In the western townships the land companies still have large holdings of uncleared land which are listed at $8 to $10 an acre. Improved farms are held at about double this valuation.

DEKALB LOAM.

The soil of the Dekalb loam is composed of about equal proportions of silt and the finer grains of sand. There is usually not more than a trace of medium and coarse sand present and the clay content seldom exceeds 10 per cent. The material is coherent, and in some instances quite plastic, molding easily between the fingers, but if moderately moist it is friable to crumbly. When dry the surface may

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be easily reduced to a fine, pulverulent condition, in which the silt content is more apparent than in the moist soil. The first few inches of cultivated land is often a loose, fine loamy sand through the accumulation of the larger soil particles at the surface, but the virgin soil is a fine-textured loam or a silty loam to a depth of 10 to 12 inches. The color ranges from a light-yellowish gray to buff. When dry the surface of old land is gray. The more silty phase assumes an ash-gray tint, which is especially noticeable in depressions and on level areas where the drainage is poor.

The subsoil is a bright yellowish-brown loam. It contains more clay and less fine sand than the soil and therefore is more compact. The clay content increases with depth to within 1 to 3 feet of the underlying rock, where the material is usually disintegrated sandstone or softened shales. The lower part of the subsoil proper is frequently a reddish-yellow silty loam containing enough clay to give it a slightly granular structure. As a rule there is too much silt in the soil mass for the latter to be well developed.

In both soil and subsoil there is more or less red-brown ferruginous gravel. In some places it has accumulated upon the surface to such an extent as to give the latter a brownish color. Usually there are very few of these iron concretions in the lower subsoil.

The depth of the soil body ranges from 8 or 10 feet on the relatively level areas to 4 or 5 feet on some of the slopes. The average may be placed at about 5 feet.

This type prevails in the eastern part of the county where the surface is not so rough as in the western parts of the area. From Cullman eastward and southward to the Warrior River most of the interstream divides have considerable areas of gently rolling land. In such localities the rate of surface and interstitial erosion is not so rapid as on the hilly areas where the greater relief induces a more rapid lateral movement of the ground water. Consequently, less of the finest material has been removed and a soil of heavier texture has been formed. In some instances the heavier character of the soil is due to a predominance of clay and clayey shales in the underlying strata. Occasionally prominent elevations within the larger area of loam have a soil of rather heavy texture due to the presence of argillaceous shales. As a rule, however, the soil on these hills and on the slopes near the drainage lines is a fine sandy loam. In the slight depressions it is unusually a heavy silty loam. If the drainage is poor the soil is very light colored and the subsoil is a mottled gray and pale-yellow silty clay, the peculiar coloration being caused by the drainage conditions. Such areas seldom include more than a few acres.

The areas of this type occurring in the southern part of the county are derived chiefly from heavy bedded argillaceous shales, and the

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soil usually contains more silt than is found in the type farther north.

The general surface features of this type render it especially desirable for general farming. It is heavy enough in texture to be reasonably well adapted to corn, grass, and other crops which require a moderately high moisture content during the growing season. In depth, structure, and texture it compares favorably with some excellent types found in other areas. If the deficiency in organic matter were supplied the present average yields of corn, cotton, and such forage crops as are raised could be greatly improved with but slight increase in the application of commercial fertilizers.

The present yields of corn and cotton may be placed at about 20 bushels per acre for the former and two-thirds bale for the latter. In the vicinity of Cullman a great variety of crops is successfully grown. Most of the sweet potatoes and strawberries shipped from that point are raised on this type. Clover and alfalfa have both been experimented with on this soil. With heavy applications of lime the deepest and heaviest phases could be made suitable for these legumes.

The value ranges from $40 or $50 an acre for improved farm land near the railroad to $8 or $10 an acre for uncleared land located at a considerable distance from any shipping point. A large proportion of the type is under cultivation. In the northeastern part of the county a large acreage has been cleared in the last few years. In this section the price has steadily increased from $5 or $10 an acre to $25 or $30 for improved land.

HANCEVILLE LOAM.

The soil of the Hanceville loam to a depth of 5 or 6 inches is a rather dark reddish-brown loam. The clay content is high and increases with depth. In cultivated fields, where the various constituents are more thoroughly commingled as deep as the land has been plowed, this change in texture is not so noticeable. Such ground is usually a friable, fine-textured loam of dark color, although the organic-matter content may be quite low. Wherever more than the average amount of vegetable matter is present the soil is exceptionally loamy, often having an open or mellow structure seldom observed in soils of sandstone origin. In the slight depressions where surface washings have accumulated the depth and friability of the material is also increased, while the soil on the gentle slopes may be heavier—a reddish-brown clay loam.

The subsoil is a clay loam, usually brick red in color, but in a few instances approaching an Indian red, and when handled stains the fingers. It has a rather high degree of plasticity, but is not adhesive, so that when very wet it is not so yielding or mirey as some clay

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loams. The granular structure of the material is very apparent in exposed sections.

The depth of the soil body does not generally exceed 8 or 10 feet and in many cases it is much less. It rests upon dark-colored sandstone which, as a rule, seems to contain a higher percentage of iron than most of the rock underlying the Dekalb soils. Very frequently pieces of hard reddish-brown sandstone occur upon the surface. Ledges of similar stone may outcrop near by, but in some localities the underlying rock is a rather soft sandstone with clayey partings, not essentially different from much of that associated with the lighter colored Dekalb soils.

Small areas of this type are found in the central part of the county. They usually occur on bench lands lying 15 or 30 feet above the general level of the nearest stream. The surface is generally undulating, with stony declivities near the drainage lines. A few small areas occupy high ridges overlooking Ryan Creek, and numerous small spots, seldom exceeding a few acres in extent, occur on the uplands in the larger bodies of Dekalb fine sandy loam. The latter are not generally typical Hanceville material, lacking the dark loamy character of the latter, although the subsoil may be bright red with a comparatively high clay content.

Crops on the Hanceville loam endure seasonal extremes remarkably well. The texture and structure of the soil body enables it to absorb and retain a comparatively large amount of rainfall. The natural drainage is good, so that any excess of water is soon removed. To this physical property of the type must be attributed, in large measure, its superior crop yields. Under the usual methods of tillage cotton produces upward of one bale per acre, and corn 20 to 30 bushels. Oats and Bermuda grass make an excellent growth on this land, and other grasses and forage crops would be found to do equally well.

At present practically all this type is devoted to cotton or corn. Some fields have produced many successive crops of the former with but little fertilization. The present yields of corn are much below what a soil of this depth, structure, and character of material is capable of producing if the content of vegetable matter were increased. Apple trees thrive particularly well on this heavy soil, and on the few high ridges where this type occurs excellent orchard sites may be found.

Only a few farms consist entirely of this type. In many instances, however, it forms a portion of the tilled land on the areas of Dekalb fine sandy loam. A little higher valuation is placed upon the "red land," since it is more productive. The price may be placed at $20 to $30 an acre, depending much upon the location with regard to market.

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The average results of mechanical analyses of a typical sample of the soil and subsoil of this type are given below:

Mechanical analyses of Hanceville loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
20234, 20236	Soil	0.1	1.0	1.7	19.9	11.7	46.5	19.2
20235, 20237	Subsoil	.5	.6	1.3	16.9	10.1	37.3	33.3

HOLSTON FINE SANDY LOAM.

The soil of the Holston fine sandy loam, to a depth of 6 or 8 inches, is a light-brown to reddish-brown fine sandy loam. When the surface has been allowed to wash, the soil is considerably heavier in texture, being usually a red loam or clay loam. The subsoil is a rather compact clay loam, containing considerable fine sand. It is crumbly rather than granular and is a good absorbent of moisture. This property, combined with the depth of the material, usually several yards, gives this type an agricultural value superior to some of the residual soils which are generally more shallow. It is also probable that the soil mass represents a greater variety of mineral constituents than is common to types of strictly sandstone origin.

The type is of rather limited extent, only a few small areas being found on the Warrior River and Ryan Creek. It occurs on old terraces from 20 to 50 feet above the streams. The material composing the upper portion of these relatively high valley lands has some resemblance to the Lafayette deposits found farther down the Warrior River. It is generally a red, sandy clay of sedimentary rather than residual origin, but contains little or no gravel. It rests upon sandstone or shale, but the thickness of the deposit is much greater than that of the soils found on some of the bench lands. The surface of the largest area has suffered considerable erosion without much exposure of the underlying rock.

This soil is valuable for general farming. The yields of corn and cotton are considerably above the average of the upland types.

The following table gives the results of mechanical analyses of samples of the Holston fine sandy loam:

Mechanical analyses of Holston fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
20238	Soil	0.7	1.4	2.3	34.6	18.2	35.1	7.6
20239	Subsoil	.3	.8	1.0	19.7	10.8	36.2	30.8

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HUNTINGTON FINE SANDY LOAM.

The soil of the Huntington fine sandy loam is usually a brown or sometimes reddish-brown loamy fine sand, containing but little coarse or medium sand, and very seldom being stony or gravelly. It sometimes contains considerable silt, especially in depressions near the bluffs, or in the lower portions of the larger areas found on the inner curves of the Warrior River. Such phases may grade into the Huntington silt loam, for the two types are closely associated.

The subsoil is generally heavier in texture, being a silty fine sandy loam. It contains enough of the finest soil particles, silt and clay, to give it considerable coherency, although it is not compact, being usually rather open in structure. As a rule the lower subsoil is a fine sand, but it presents many variations in texture and structure. The underdrainage, however, is usually good.

The type represents all the lighter alluvial soils on the Warrior River and the tributary streams in the area. Owing to its origin, it necessarily presents considerable variation in texture, depth, and drainage conditions.

Most of this soil is under cultivation, producing about 1 bale of cotton per acre and from 20 to 30 bushels of corn. It is easily cultivated, and even if overflowed in the spring it generally dries off rather rapidly after the water subsides.

The content of vegetable matter is low. Many fields were found where no attempt had been made for a long period to renew the fertility by plowing under green crops. The latter would be highly beneficial in most instances, and would greatly enhance the value of the type for growing corn. Some very desirable areas for raising certain kinds of truck may be found on this bottom land, provided future markets or transportation facilities warrant the attempt. The deep, brown loamy sand which forms the gentle undulations on some of the larger areas is well adapted to watermelons, cantaloupes, sweet corn, or tomatoes. On similar locations it is probable that alfalfa could be grown with considerable success.

The average results of mechanical analyses of representative samples of this type are shown in the following table:

Mechanical analyses of Huntington fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
20226, 20228.....	Soil.....	0.0	0.4	2.7	41.2	21.9	27.1	6.5
20227, 20229.....	Subsoil.....	.0	.1	1.6	33.0	21.6	30.1	13.4

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HUNTINGTON SILT LOAM.

The soil of the Huntington silt loam is a dark-brown silt loam, consisting chiefly of the finer grades of mineral particles and usually containing but little humus. It is rather open in structure, the surface being very friable and easily reduced to a good state of tilth. In many instances there is but little difference between the soil and subsoil in color and texture. The entire soil section may consist of essentially the same material, with a slight change in color, the lower part being a lighter or yellowish brown, depending somewhat upon the effectiveness of the underdrainage.

The Huntington silt loam is found in a few places on the Warrior River. These areas are subject to occasional overflow, but for the most part they are high enough to have fairly good drainage. The areas occurring on the small creeks are usually narrow strips and necessarily vary considerably in texture, ranging from a sandy loam to a very heavy silt loam. All of the soil, however, contains a high percentage of silt, which gives it the friability and moisture-holding capacity usually possessed by silt loams.

Most of the type has good natural drainage and as a whole represents the heaviest alluvium found in the area. It is largely derived from shales and occurs on those locations where alluvial deposits of clay and silt should be expected from the character of the surrounding uplands.

A phase of the type occurs along some of the streams where in most places it is underlain at a depth of a few feet by horizontal layers of hard, slaty rock. This, of course, prevents the normal movement of the ground water and consequently much of it is subject to extremes of saturation and dryness. This is indicated by the pale yellow or mottled gray and yellow material with small iron concretions. In wet seasons it is difficult to keep fields in a good state of tilth. Near the foot of the hill where the soil of this phase has a greater depth than in the middle of the valley, the drainage may be fairly good, while the central portions are water-logged. During a short drought the latter may become quite dry down to the underlying rock. Most of this phase is better adapted to grass than to cultivated crops, although where the average depth of the soil exceeds 3 feet and the surface drainage is effective, cotton, corn, and sorghum are successfully grown.

Much of the Huntington silt loam is under cultivation. The yields of corn, for which most of it is well adapted, range from 20 to 50 bushels per acre. Cotton is planted on the better drained and lighter phases and produces upward of 1 bale per acre. A small proportion is devoted to hay—the native varieties, crab and sedge grass, soon occu-

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pying old fields, while the more desirable Bermuda grass and Japan clover need but little encouragement to make an excellent growth.

Apart from the rougher land with which it is associated, this type is valued at about $25 an acre.

The following table gives the average results of mechanical analyses of samples of this type of soil:

Mechanical analyses of Huntington silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
20230, 20232.....	Soil.....	0.1	0.3	0.2	7.1	19.4	52.5	20.3
20231, 20233.....	Subsoil.....	.1	.1	.4	15.1	20.9	41.0	22.7

ROUGH STONY LAND.

Rough stony land embraces those areas of nonarable land found in the deeper stream gorges and on the steep flanks of the "mountains." Where the topography precludes the use of the land for agricultural purposes no classification of the soil has been made. It necessarily varies greatly in depth and character. Much of the surface is bare rock outcrop, as on lower Ryan Creek and on some of the other streams in the southwestern part of the county. The steep slopes above these outcrops and in the ravines usually merge into a stony loam on the higher ground.

In the southern part of the area, where the table-land drops off abruptly to the shale loam, the steep hillsides usually consist of shale outcrops. In places there may be but little stony material. There are also occasional coves where a few acres of cultivated land may be found. The small isolated areas near Arkadelphia are conical hills or short ridges of shale capped with sandstone.

Except for the standing timber most of this type has little agricultural value. It is better adapted to forestry than to other purposes.

SUMMARY.

Cullman County is located in the north-central part of Alabama. It includes 741 square miles of the Cumberland Plateau. The general elevation of the northern part is about 800 feet above sea level with a gradual decline toward the south. The eastern half is rolling to moderately hilly, with the steepest hills along the larger creeks. In the western part the divides are generally narrower, with much hilly and broken ground as they descend to the creeks. The flat-topped spurs of the northwestern portion consist largely of "moun-

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tain" lands bordered by deep gorges. The south-central townships have a lower average elevation. The topography consists more generally of ridges with narrow valleys between.

All the area was originally forested. About one-fifth is now under cultivation. The central part is the most thickly settled. Some of the outlying townships which contain considerable rough land are rather sparsely settled. Many Germans have located in the middle part, while the remainder is occupied by people from Georgia. Most of these settlements have been made in the last thirty-five years.

The winters are mild and the long summers are agreeably modified by the elevation. The annual rainfall is about 60 inches.

The farms are generally small and nearly all are operated by the owners. The agricultural class constitutes all but about 3,000 of the county's population. There are very few negroes.

Cullman, the county seat, is the chief market and distributing point. It is located on the Louisville and Nashville Railroad, which crosses the area from north to south.

Cotton and corn are the principal crops. The former is the "money crop," with practically all the farms located some miles from the railroad. Near Cullman strawberries and sweet potatoes are raised in large quantities. In this section the general farming is also more diversified than in the eastern and western portions.

The price of improved land ranges from $10 an acre in the extreme southern and western parts of the county to $50 an acre near Cullman. Uncleared land, suitable for farming, ranges in value from $5 to $20 an acre.

Most of the area is in the earlier stage of agricultural development. Much land is now being cleared and improvements of many kinds are in progress. Excellent opportunities exist for the profitable production of pork, poultry, and dairy products. Very little attention is given to stock raising.

The soils are residual, being derived chiefly from sandstones and noncalcareous shales. The average depth is perhaps 5 feet, rock or shale usually occurring at about that depth. Besides some areas of Rough stony land, ten soil types were encountered. The Dekalb and Hanceville soils are upland types, while the Huntington types are alluvial soils of limited areal extent.

The Dekalb stony loam occurs along the streams. Very little of it is under cultivation.

The Dekalb fine sandy loam and loam are associated types having an extensive development in this area. Both are well adapted to cotton, potatoes, berries, and a great variety of forage crops. The loam is the more desirable for general farming, where corn, oats, and grass may be made the principal crops.

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The Dekalb shale loam is a heavy type covering much broken land in the southern part of the county. In the little valleys some very desirable farm land is found which produces good crops of cotton and corn.

The Hanceville loam, a heavy dark reddish-brown soil, is generally superior in agricultural value to the Dekalb soils.

The small areas of bottom and terrace lands in the southern part of the county are essentially local types. The Huntington soils are valuable for corn, to which they are generally planted. The fine sandy loam affords some excellent land for trucking, but the distance from markets prevents its profitable use for this purpose.

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SOIL SURVEY OF CALHOUN COUNTY, ALABAMA.

By LEWIS A. HURST, of the U. S. Department of Agriculture, and PHILIP H. AVARY, of the Alabama Department of Agriculture and Industries.

DESCRIPTION OF THE AREA.

Calhoun County, Ala., is located in the northeastern part of the State, near the Georgia line. It is situated just south of parallel 34° north latitude, while meridian 86° west from Greenwich passes through the western portion of the county. Cleburne and Talladega counties bound it on the east and south; Cherokee and Etowah on the north; and Etowah, St. Clair, and Talladega on the west. The Coosa River, which has a general southwesterly course, separates it from St. Clair County. The county comprises an area of 397,440 acres, or 621 square miles.

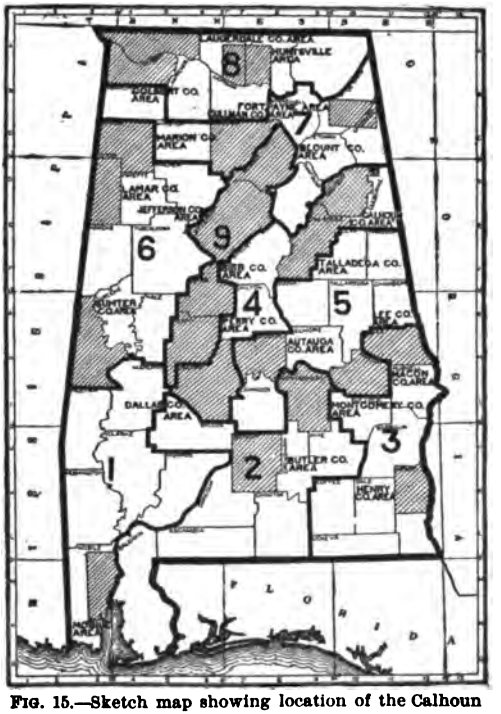

FIG. 15.—Sketch map showing location of the Calhoun County area, Alabama.

Practically all of the county lies within the Coosa Valley region, with the exception of a narrow strip along the eastern boundary, which is occupied by an extension of the Appalachian Mountain system. This is a deeply eroded plateau consisting of sharp ridges and narrow V-shaped valleys, with elevations varying from 1,000 to 1,200 feet or more above sea level. The Coosa Valley section ranges in elevation from about 600 feet, in the valleys proper, to over 2,000 feet upon the peaks of Choccolocco and Coldwater mountains. It is made up of ridges and valleys which have a general northeast to southwest course across the county. The Choccolocco and Coldwater

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mountains form the main watershed and determine largely the direction of the streams. On the eastern side of the Choccolocco range occurs the Choccolocco Valley, drained by the creek of the same name, which leaves the county south of Oxford. Here the valley broadens to something over 4 miles in width. The Dugger Mountains serve to turn a portion of the drainage north through Nancy and Terrapin creeks, which leave the county northwest of Piedmont. The moderately rolling country about Piedmont has been largely carved by these streams. On the western side of the Choccolocco Mountains the drainage is largely through Ohatchee, Tallahatchee, and Cane creeks, with their tributaries, which flow in a general westerly course and empty into the Coosa River. The latter forms the main outlet for all the drainage of the county and has vast possibilities for developing water power. Coldwater and Estaboga creeks drain the southwestern section of the county.

Calhoun County was organized December 18, 1832, and was called Benton County until 1858. It was formed from territory ceded by the Creek Indians. The first settlement was made in 1830, in the vicinity of White Plains, which later contested for the court-house, but lost to Jacksonville, the latter becoming the first county seat in 1837. It remained here until 1903, when it was transferred to Anniston. The early settlers came from Tennessee, Georgia, Virginia, and the Carolinas, but mostly from Georgia and Tennessee. The county was settled gradually, but by 1860 the population had increased to 21,539. After the close of the civil war, and with the advent of the railroads, additional settlers came from sections farther north. They assisted in opening up the ore mines and gave an impetus to manufacturing. With the addition of immigrants from the surrounding States the county, according to the census of 1900, had a population of 34,874, of which 9,695 were in the city of Anniston. Oxford, Jacksonville, and Piedmont each have a population of more than 2,000. Other towns and villages are Bynum, De Armanville, Choccolocco, Ironcity, White Plains, Weaver, Zula, Tredegar, Angel, Wellington, Ohatchee, Duke, and Alexandria.

The building of cotton mills, iron furnaces, and various public works have in recent years attracted large numbers of people from the rural districts to the cities and towns, where they obtain employment. The desire for better school facilities and the scarcity of labor have also been reasons for the desertion of the rural districts by the larger landowners. A large percentage of the present rural population is made up of tenants and small farmers.

With the profits obtained from stock raising, dairying, and more intensified methods of farming, new settlers are being attracted to the better sections of the county, and they are improving the land which was formerly run down and had been largely turned over to tenants.

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More encouragement should be given immigrants seeking to establish homes in the rural districts by dividing the large landholdings.

Anniston, founded in 1872 by the erection of the first iron furnace in the county, is by far the largest commercial center, and (1909) has a population estimated at 18,000. It has all the modern conveniences—waterworks, sewerage, electric lights, street railway, fire department, public libraries, paved streets, and cement sidewalks. The water supply is obtained from a battery of springs, located at Coldwater, 7 miles out, having a flow of 22,000,000 gallons a day of clear, pure water. This doubtless accounts for the healthfulness and low death rate of the city. Besides several iron furnaces, car shops, pipe works, etc., the manufacturing plants include six cotton mills. Its educational institutions include, besides the public school, Noble Institute, Anniston Female College, and the Alabama Synodical College for men. One of the State normal schools is located at Jacksonville, while Oxford College, one of the oldest institutions in the State, is located at Oxford. Piedmont also has a high school, and each of these places has a large cotton mill in operation, giving employment to several hundred hands.

The first railroad built in the county included the extension of what is now the Rome and Meridian Division of the Southern Railroad, which was built from Talladega to Blue Mountain shortly after the close of the civil war. This road was soon extended through Jacksonville and Piedmont to Dalton and later to Rome, Ga., where it connects with the Southern Railway from Atlanta to Chattanooga and Cincinnati. The East and West Railroad, now operated by the Seaboard Air Line, was built in 1884. This line crosses the northern half of the county and gives ready access to the markets of Birmingham, Ala., and Atlanta, Ga. The Alabama Mineral Division of the Louisville and Nashville runs north from Anniston to Birmingham, and passes through the center of the county, crossing the Seaboard Air Line at Wellington. The Calera branch of the same road furnishes connection at Calera with the main line of the Louisville and Nashville Railroad leading to Montgomery, New Orleans, and Birmingham. The Atlanta and Birmingham division of the Southern Railroad crosses the southern portion of the county from east to west. Transportation facilities are also afforded by the Coosa River, which is navigable from Lock 4 in Talladega County to Rome, Ga., and flat-bottom steamers ply between these points the year round.

There are 850 miles of public road in Calhoun County, some of which have been macadamized, and there is an abundance of material at hand for improving the rest of the roads. A sample road built by the United States Government, connecting with the main street in Anniston, shows the possibilities for good roads. Con-

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siderable attention has been given to road building within the past few years and in many instances the latest improved road-building machinery has been employed.

Better school facilities are being established in rural sections. The extension of rural telephone lines and the rural free delivery of mail to all sections of the county are some of the more recent improvements. Before the advent of the railroads the marketing was practically all done at Wetumpka, Ala., and Rome, Ga., but at present the exchange of commodities is through Atlanta, Ga., Chattanooga, Tenn., Birmingham, Montgomery, and Mobile, Ala., and New Orleans, La. Considerable exports are shipped via Savannah, Ga., and Charleston, S. C. The two chief staples, cotton and corn, are sold locally, a large percentage of the cotton being consumed by the local mills. Very little of the feed stuffs raised is marketed outside the county, as the demand far exceeds the supply. Atlanta, Ga., and Birmingham, Ala., with their rapidly growing populations, will furnish increased demands for the excess of such farm products as fruit, truck, butter, eggs, and poultry, most of which at present is consumed in the area.

CLIMATE.

The climate of Calhoun County is mild and equable, with relatively short winters and long growing seasons. The summer heat is tempered by mountain breezes, so that oppressive days and sultry nights are of rare occurrence. The mean annual snowfall is less than 3 inches, and snow never remains on the ground longer than one or two days. The mean annual temperature is about 62° F., ranging from 44° in winter to 77° in summer. The extreme temperatures of winter and summer are −10° and 103° F., respectively, but these are of rare occurrence, and 95° to 100° F. in summer and 10° to 70° F. in winter are conservative extremes. The average date of the first killing frost is October 20, and very little damage occurs from this source after April 15. The mean annual precipitation is slightly less than 50 inches, and is well distributed throughout the growing season. The least precipitation occurs in the fall, making it especially favorable to the gathering of cotton and other crops.

The climatic conditions are favorable for the growing of winter forage crops and pasture is available practically all the year round. Shelter for stock should be provided at night, especially in winter and during the rainy season. The cold snaps, or "northers," as a rule never last longer than from one to three days, and are not severe enough to cause the ground to freeze more than 2 or 3 inches, which usually thaws in a day or two. The long growing season, from April to October, gives ample time for the maturity of all crops,

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and a succession of some crops can be harvested from the same field in a single season. The long season is especially favorable for trucking.

On account of the healthfulness and pleasant summer climate, many resorts have been established in the mountains, which attract tourists from various sections of the North and South. These are usually located with reference to mineral springs, which are highly valued for their medicinal properties. Aside from these, the county is amply supplied with pure, clear limestone and freestone spring water. Many of the springs have a flow of thousands of gallons a day.

The following table, compiled from data gathered by the Weather Bureau station in Anniston, located in the southern part of the county, shows the prevailing climatic conditions:

Normal monthly, seasonal, and annual temperature and precipitation at Anniston.

Month.	Temperature.			Precipitation.			
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year.	Total amount for the wettest year.	Snow, average depth.
	°F.	°F.	°F.	Inches.	Inches.	Inches.	Inches.
December	44	75	7	3.7	4.7	2.3	0.6
January	44	73	7	5.2	4.1	7.1	0.4
February	44	75	−10	4.9	3.8	2.1	1.7
Winter	44	.....	.....	13.8	12.6	11.5	2.7
March	55	84	12	5.4	3.5	6.9	0.3
April	61	88	27	4.6	2.6	3.8	0.0
May	69	94	36	4.0	2.7	10.6	0.0
Spring	62	.....	.....	14.0	8.8	21.3	0.3
June	76	100	44	4.0	4.1	7.6	0.0
July	78	102	56	5.3	4.2	4.1	0.0
August	78	103	56	3.9	1.0	5.1	0.0
Summer	77	.....	.....	13.2	9.3	16.8	0.0
September	73	98	36	2.4	2.5	2.3	0.0
October	63	92	30	3.0	1.5	2.7	0.0
November	51	82	16	2.7	3.8	1.5	0.0
Fall	62	.....	.....	8.1	7.8	6.5	0.0
Year	62	103	−10	49.1	38.5	56.1	3.0

Average date of first killing frost in autumn, October 20. Average date of last killing frost in spring, April 2. Earliest killing frost, October 6, and latest, April 20.

AGRICULTURE.

In the early days the marketing of the area was done largely at Wetumpka, Ala., and Rome, Ga. Produce was hauled to these markets by wagon, which made it unprofitable to grow many crops

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or to practice diversified farming as it is now understood. Whatever the pioneer produced was mainly for home consumption. Corn was the principal crop, but wheat, potatoes, and other truck crops were grown. The little cotton grown was ginned by hand, which, together with the wool obtained from the sheep, furnished the raw material out of which the homespun clothing, etc., was made. Some hogs of an inferior grade were allowed to roam in a half-wild state through the county. Wild game was plentiful and was the chief source of meat supply. Through the introduction of the cotton gin and the establishing of better market facilities and by the building of railroads the agriculture of the area developed rapidly.

In 1860 there were 125,306 acres improved and 246,619 acres unimproved farm land in the county, the total valuation being $2,709,394. In 1870, the farmers not yet recovering from the ill effect of the civil war, the number of acres in improved farms decreased to 68,234, but by 1880 there was an increase of 27,097 acres and in 1900 the acreage of improved farm land had increased to 100,622 acres. The value of live stock decreased from $812,766 in 1860 to $326,008 in 1880. By 1890 it had increased to $435,190 and in 1900 to $501,277. The acreage in wheat in 1900 was 5,673, the production being one-fifth what it was in 1860. From 1860 the production of oats has steadily increased until 1890 when the census, reporting for the year 1899, give the output as 101,338 bushels. However, in 1900 the crop decreased to 27,330 bushels. Corn decreased from 655,193 bushels in 1860 to 239,451 bushels in 1870. In 1900 it had increased to 453,280 bushels. The production of cotton has steadily increased from 3,038 bales in 1870 to 11,764 bales in 1900. The yield in 1906 was 14,525 bales, an increase of 2,761 bales. While these fluctuations may in part have been due to seasonal differences influencing the yield of crops, they may be taken as indicating broadly the general trend of agricultural development in the county.

Cotton and corn are the staple crops at present and as large an acreage of these is grown as can be with the available labor. Some attention is being given to crop rotation and the planting of winter cover crops, but the practice is largely confined to the smaller farmers who cultivate their own farms. The tenants follow almost exclusively the "one-crop" system, the only rotation ever practiced being the occasional substitution of corn for cotton. Sometimes a few cowpeas are planted with the corn, but the practice is not general. The productiveness of the soil is maintained almost exclusively through the use of commercial fertilizers, for which $30,000 is annually spent. The census reports, however, for the past twenty or thirty years show a considerable reduction in the quantity used, which is no doubt due to the better methods of cultivation and the

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increased production of hay and feed stuffs among the more progressive farmers. Some barnyard manure is used, but very little care is taken in its conservation.

The production of oats and wheat should be greatly increased, since they serve as winter cover crops and are excellent for forage in the early spring. Johnson or Bermuda grass could be grown with profit upon areas which usually lie idle for lack of labor, the amount of labor required to harvest the hay crop being small where improved machinery is employed. Although as much as 5 tons of hay in 5 cuttings are obtained in favorable seasons, the production seldom equals the demand, which would be vastly increased if more attention were given to raising mules, horses, and cattle. Where Johnson grass is properly cultivated and not allowed to become "sod bound" it makes excellent pasture. The spreading of the grass to the cultivated fields has been the objection to its culture, but this can be overcome largely by careful management. If the grass is properly turned up and a sufficient number of hogs allowed to graze upon it to root out the grass thoroughly, it can be killed when it is desired to cultivate the fields afterwards. Its greatest good would be to prevent washing upon those fields which are usually not properly cultivated. Bermuda grass also makes an excellent hay crop and could be grown for pasture and hay upon the heavier soils along the bottoms which are subject to overflow. Millet and Hungarian grasses are coming into more general use. Cowpea and velvet bean hay is a valuable asset to stock raisers, and its use should be extended. It is especially valuable as a source of nitrogen, and the humus supply of the soil could be built up largely through the growing of these legumes.

In the vicinity of the larger towns dairying, trucking, and fruit growing have been successfully conducted. These products are largely consumed in local markets. Strawberries, raspberries, and blackberries command a ready sale and the supply very seldom meets the local demand. Blackberries and huckleberries grow wild. Watermelons, cantaloupes, and cucumbers can be successfully and profitably grown, but the local demand is seldom satisfied. Sorghum is grown mostly for sirup, but it is a valuable forage crop and should be grown more extensively for this purpose.

The average size farm, as given in the Twelfth Census, is 74.5 acres. In the census classification each tenant holding was counted as a distinct farm, and the average holding is therefore much greater than the figure given. There are a good many holdings containing from 1,000 to 3,000 acres or more. In some cases several square miles are owned by some of the mineral land companies, but most of this land is in native timber, and large areas are unsuited for general farming purposes. The land values in the county have slightly advanced in the last few years and are continuing to advance steadily.

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The hill lands range in price from $2.50 to $10 an acre and the valley lands from $10 to $40 an acre, some of the more desirable bottom lands bringing as high as $60 to $70 an acre when improved.

Less than one-third of the farms are operated by the owners, most of the farming being done by tenants under three principal systems, differing mainly in the method of paying rent. In some instances a fixed cash rent is determined upon, ranging from $2 to $3 an acre, or from 1 to 2 bales of cotton to the one-horse farm, which on a valuation of $10 to $20 an acre gives a better profit than is generally obtained from the use of money in other investments. When the crop is worked on shares the landlord usually furnishes half the fertilizer and seed and in addition furnishes the mule and farm implements. Clothing, food supplies, and other necessaries are usually advanced to the tenant through the season and a lien taken on the crop to pay for them.

The tenant is allowed as much land as he can successfully cultivate, but usually not more than 15 or 20 acres are planted in cotton, the remainder being planted in corn. Almost no attention is given to seed selection. The plowing is usually shallow and the cultivation done at irregular intervals without reference to the moisture conditions, no precautions being taken to conserve the moisture. The fertilizers used are generally of low grade, and phosphates are applied at the rate of 150 to 300 pounds to the acre, the application usually being made at the time of planting, except when corn is given an extra top dressing of nitrate of soda at the time of "laying by" the crop.

With the prevailing high price of cotton and corn, the tenants have been fairly prosperous, but a large percentage of them carry some indebtedness from year to year. With the small farmers, however, who own and tend their farms, better conditions prevail, as shown by the general character of improvements on their farms.

The farm labor is furnished almost exclusively by negroes, who receive from 50 cents to $1 a day, with board or rations in addition. The demand in recent years for this class of labor on public works has greatly increased the cost to the farmer. Cotton is usually picked at a stipulated price, ranging from 50 to 75 cents per 100 pounds. The labor, while not as efficient as is frequently desired, meets the usual requirements of the methods of cultivation most generally practiced, but improvements in farm management must come largely through the owners who operate their own farms, as the tenant's lease usually expires after the crop is made. By keeping more live stock and utilizing the barnyard manure the fertility of the soil could be increased and the expenditures for commercial fertilizers greatly reduced. In this connection, oats and cowpeas for hay are probably the most economical and profitable crops that can be grown. In addition to supplying nitrogen and humus to the

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soil, they have a high feeding value and meet with ready sale in the markets. Where these have been introduced into the rotation of crops striking results have been obtained.

The raising of beef and dairy cattle and the grazing of sheep and goats would doubtless prove profitable, especially upon the rougher, mountainous areas. The steady increase in value of timber land should encourage the use of second-growth land for forest purposes, particularly upon the higher and stonier soils, or upon those not generally suited to agriculture. Wide areas of land occur throughout the county which should never be used for any other purpose, and upon which a high grade of longleaf and shortleaf pine can be grown in from fifteen to twenty-five years.

The mild climate and long growing season, together with the variety of soils, makes it possible to grow a wide range of crops. In so doing the farmer becomes more independent of price fluctuations, and his income is more uniform and certain. His expenditures are less, because he can raise most of what be consumes, and he can manufacture to a large extent his own fertilizers.

In preparing the soil for cotton the stalks of the previous year are usually broken down either with a hand flail or by dragging a log over the field. In recent years the stalk cutter has been introduced by some of the more progressive farmers. This not only breaks down the stalks, but cuts them into fine pieces so that they can be more readily turned into the soil. The land is usually given a shallow plowing, either in the fall or spring, and the soil thrown into ridges, their crests being between the rows of the preceding year. If the ridging is done in the spring the fertilizer is usually added in the first furrow and the ridging done on top. In case the soil is broken twice the fertilizer is added in the first furrow of the second breaking. The seed is planted either the latter part of March or the early part of April, being dropped along the tops of the ridges, usually with a one-horse cotton planter, which opens the furrow, drops the seed, and covers it in the same operation.

Somewhat the same method is followed in the preparation and planting of corn land, although the breaking is more often done broadcast either in the fall or early spring. As in the case of the cotton land, however, the breaking is seldom deeper than 2 to 4 inches. Oats rank next in importance to corn and cotton. This crop is usually sown in the fall, between September 15 and November 15, but it is best to sow it in September or October. By the use of grain drills both fertilizer and seed are put down in the same operation, and the use of the drill is commended in that it insures a more even distribution of the seed and fertilizer and a better preparation of the seed bed, because it is necessary to break and harrow the soil before the seed can be drilled. About the same practice should be

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followed in sowing wheat. The most common method of cultivating cotton and corn consists in running a shovel plow or "scooter" next to the rows and following it up throughout the middles, while the subsequent cultivation is done with "sweeps," a larger size being used for each succeeding cultivation which insures a fairly flat cultivation. The use of the "scooter" next to the rows often injures the plants by pruning the roots too severely and does not conserve the moisture as well as a light cultivation.

The period during which any crop can be grown successfully and economically without rotation depends largely upon the character of the soil and the conveniences for cultivating it. The common practice is to grow corn, oats, and wheat on the lower bottom lands, or second bottoms, and the cotton upon the uplands. The hill soils are used for all the crops, except where basins occur, and here corn is more often grown. These are also used for growing apples, while the higher slopes and tops of the ridges are more often used for peaches. Tobacco for home use is also frequently grown upon the hill lands.

Deeper breaking and more thorough tillage, preferably in the fall, including frequent harrowing to conserve the moisture until planting time, followed by shallow cultivation, which should be continued longer than is ordinarily practiced, is recommended for the uplands. Instead of plowing the corn and cotton the first time with a "scooter" a better practice would be to give these crops level, shallow cultivation of 2 or 3 inches, using a harrow-tooth cultivator for the first two cultivations, followed by the larger sweep. This gives a more thorough cultivation of the surface without injury to the roots, and the destruction of weeds is equally as effective as by the other method, besides the moisture is more surely conserved and the soil is left in a much more favorable condition for the absorption of rainfall. Where crop rotation is practiced the various legumes, cowpeas, peanuts, clover, velvet beans, etc., should be grown as often as possible. In a three-year rotation of cotton, corn, and oats, one of these crops, preferably cowpeas or velvet beans, should be sown broadcast or in rows between the corn rows. Oats should always be followed by one of these crops after they are harvested. When cotton is grown year after year on the same uplands it is recommended that crimson clover, bur clover, or oats or rye with vetch be sown in the middles to prevent washing and to absorb the plant food as it becomes available, at the same time providing winter pasture. Clover, as a rule, does not make a start for the first year or two without inoculation, but if the practice is continued for a few years the soil seems gradually to become inoculated and the growth becomes luxuriant, furnishing a source of excellent hay and pasture and adding a store of nitrogen to the soil.

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The selection of crops best suited to the soils and the breeding of varieties of cotton which show a special adaptation to the soils and climate and the selection of better seed are equally important factors in increasing the return of the farm. Where the shipping facilities are adequate, strawberries, raspberries, blackberries, peaches, apples, pears, plums, prunes, potatoes, tomatoes, watermelons, cantaloupes, cucumbers, etc., could be grown with profit for shipment to the northern markets, and better returns obtained from the land than in the continuous growing of cotton and corn. The valley lands afford excellent opportunities for raising horses, mules, and cattle, being well supplied with perennial streams, the bottoms along which afford excellent pasture. These valley lands produce heavy yields of grain and hay when properly handled. Little dairying is practiced in the county, but it could be carried on profitably either alone or in connection with truck growing, especially in the vicinity of Anniston, Oxford, Jacksonville, and Piedmont, if these places were supplied with creameries to manufacture the milk into butter, cheese, and other products.

The use of more improved machinery is especially recommended to those who cultivate the flat, moderately rolling valley lands. It has been shown that the wide variation in the earning capacity of farmers in various sections of the country is due mainly to the ratio of horsepower to the number of laborers employed. In some of the Northern States the farm worker produces $600, and about four horses for each worker is used. In the Southern cotton-growing States each farm worker produces about $145 and about two laborers to each mule are employed. The use of labor-saving machinery also makes the farmer less dependent upon labor. On the whole the agricultural conditions in the county are encouraging and more demands are being made on the farmers for their products by the increase of the nonagricultural population engaged in manufacturing and developing the mineral resources of the area. The rapid growth of the larger cities of northern Alabama will also make great demands on the farms of Calhoun County for their food supply and feed stuffs.

SOILS.

The materials which go to form the various soil types encountered in the survey of Calhoun County are derived largely from the underlying geological formations.[a] Eight different geological formations occur, extending from the Archæan through the Cambrian, Silurian, Devonian, and Subcarboniferous to the Carboniferous age. These

[a] Data relative to the geology of Calhoun County were kindly furnished by Dr. Eugene A. Smith, state geologist of Alabama. Use was also made of his Report on the Valley Regions of Alabama.

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formations represent the different deposits which were spread out over the ocean floor at different peroids, and later when this region was elevated and became a land area the different deposits became solidified and in some cases metamorphosed. The depositions thus made include conglomerates, sandstones, limestones, and shales of varying degrees of purity, hardness, and color. Calhoun County forms a part of the Appalachian Mountain system, which extends from central Alabama to northeastern Pennsylvania. In the processes of elevation or mountain building the rocks were so distorted, crumpled, and folded that they now outcrop at various angles at the surface and give rise to a great variety of soil conditions. These soil conditions were assembled into groups, and within each group the materials having similar origin, texture, topographic features, color, and agricultural value were separated and mapped as types.

The rough broken character of the surface of the area is not due entirely to the uplift of the various formations, but is also due to the processes of erosion. The eroded materials have been transported and laid down along the various streams and this has given rise to a certain class of soils. In the rough mountainous country, south and east of Choccolocco Valley, the crystalline rocks, probably Lower Cambrian in age, give rise to the soil type mapped as Talladega slate loam. The rocks from which this type is derived exhibit a variety of colors, from dark green to lustrous pearl. The shales have a greasy talcose feel, and this is also characteristic of the soil and subsoil. Accompanying the shales and interbedded with them are conglomerates, quartzites, and veins or lenses of quartz, fragments of which frequently occur upon the surface.

The most important geological formation of the county includes the purer limestone and cherty siliceous limestone known as the Knox dolomite, which, upon weathering, gives rise to the Decatur clay loam, Decatur loam, Decatur stony loam, Clarksville loam, Clarksville stony loam, and Clarksville gravelly sandy loam. The members of the Decatur series are the most productive upland soils in the area and are derived from the purer limestones, while the Clarksville soils are more siliceous or cherty, the size and amount of chert fragments being the main difference between them. These are fairly productive soils and are used extensively for general farming, except upon the rough stony areas.

Derived from the shale formations, including interstratified sandstone, are the Dekalb loam, Dekalb shale loam, Conasauga clay, and Montevallo shale loam. All but the last-named type are classed with the flat woods and are known locally as "post-oak lands," and represent some of the less productive, easily eroded soils. From the Weisner sandstone and conglomerate formations are derived the Dekalb stony loam, Dekalb sandy loam, and the greater portion of the

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Rough stony land, which usually occur as mountain types, and with the exception of the Dekalb sandy loam are not used extensively for general farming purposes.

The Huntington fine sandy loam and Huntington silt loam occur as first and second bottom lands along the several branches, creeks, and the Coosa River. They are formed from sediments transported long distances or washed in from the surrounding uplands. These soils are frequently lacking in drainage, which is usually supplied through open ditches.

The following table gives the name and extent of each of the eighteen types of soil found in Calhoun County:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Clarksville stony loam	91,840	23.1	Clarksville gravelly sandy loam	11,648	2.9
Rough stony land	42,368	10.7	Montevallo shale loam	9,600	2.4
Dekalb stony loam	40,256	10.1	Holston gravelly sandy loam	7,680	1.9
Huntington silt loam	32,832	8.2	Holston fine sandy loam	6,208	1.6
Dekalb loam	30,208	7.6	Dekalb sandy loam	1,024	.3
Decatur clay loam	29,120	7.3	Conasauga clay	704	.2
Decatur stony loam	28,032	7.1	Clarksville loam	704	.2
Talladega slate loam	20,032	5.0			
Dekalb shale loam	17,600	4.4			
Huntington fine sandy loam	14,528	3.7	Total	397,440	.....
Decatur loam	13,056	3.3			

DECATUR CLAY LOAM.

The soil of the Decatur clay loam, to a depth of 4 to 8 inches, with an average depth of 5 inches, is a chocolate brown to dark-red heavy loam or clay loam. In the depressed or flat areas, where organic matter accumulates more rapidly, the soil is deeper and of a deep-brown to black color. Eroded areas frequently occur which give the soil a spotted appearance. The subsoil is more uniform than the soil, in color and texture, being a dark-red, rather stiff silty to sandy clay. It is more sandy where the soils from the mountains have entered in part into its composition. It contains sufficient sand to be friable or brittle when dry, but when wet it is quite plastic. The surface soil is sometimes sandy, and where such areas were of sufficient size they were separated and classed with the Decatur loam.

The occurrence on the knolls of a small amount of quartz, chert, and sandstone fragments, some of which are rounded, would seem to indicate that the derivation of the surface soil was probably to some extent influenced by materials reworked by stream action or possibly by the breaking down of conglomerate. Partially disintegrated chert and bowlders of limestone were occasionally observed buried in the

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subsoil, but in general it is quite free from stones or gravel, the weathering having taken place to considerable depths.

This type is strictly a valley soil, and it is most extensively and typically developed in the Alexandria and Jacksonville valleys. Other less extensive areas occur in the vicinity of McFall, Piedmont, Bynum, Anniston, and along the courses of Choccolocco, Chattaquilla, and Nancy creeks.

Where the type occurs in the vicinity of the Choccolocco and Coldwater mountains, the soil and subsoil are lighter or more sandy in texture, but have the same characteristic dark-red to brown color. The texture of the soil in these areas is somewhat similar to the Decatur loam, but the depth is seldom more than 5 inches, and if plowed to a depth of 6 to 8 inches it develops more of a clay loam texture. In addition to being better drained, it is a warmer and easier soil to cultivate.

The Decatur clay loam, being the heaviest soil in the county, is naturally the most difficult to handle, especially during wet seasons or seasons of prolonged drought. It is a tough and hard soil when dry, and if too wet it does not readily scour. When plowed in this condition it forms clods. This is due in part to the lack of humus. The best results have been obtained by the use of the revolving disk plows, which, however, require more horsepower to operate than is available to the average tenant.

Except for a few sidehill areas, this soil has a fairly uniform, gently rolling surface, and over the greater portion of it the most improved labor-saving tools and machinery can be used. If not properly cultivated the soil easily erodes. Terracing, however, is not generally needed, but deeper plowing and the growing of winter cover crops should be more generally practiced.

The surface drainage is usually sufficient, although small basins occur throughout the type which would be materially benefited by artificial drainage. The stiff character of the subsoil and the shallowness of the soil is naturally conducive to a low water-holding capacity. The precautions suggested to prevent erosion will also increase the power of the soil to hold water and insure better yields, both in times of drought and of excessive rainfall. Subsoiling, the addition of organic matter in the form of barnyard manure, and the growing of legumes should be more generally practiced.

The Decatur clay loam was formed by the breaking down or weathering of the Aldrich (Beaver) limestone, the siliceous Knox dolomite, and chert, which belong to Cambrian and Silurian periods. The rock that has entered most into the formation of this soil type consists of the purer and less siliceous strata. Occasional outcroppings of the Knox dolomite were observed along stream courses.

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The original material seems to have contained a relatively large quantity of iron compounds, as pockets of iron ore consisting of limonite and red hematite have been mined at various places. The oxidation of this high content of iron in the soil is the source of the deep-red color, which is its distinguishing feature.

The Decatur clay loam is the strongest soil in the county and is capable of being made the most productive. With the usual methods practiced, however, the Decatur loam is about equally productive. The original growth upon this type was largely hardwood, although considerable pine has been removed. Practically all of this land has been cleared, and most of it is under cultivation. Where badly eroded, it is allowed to grow up in briers, wild plum, and field pine, which protects the soil from washing until a new soil is made, after which it is reclaimed as "fresh land."

This soil type is particularly adapted to intensive and diversified farming. The higher and better drained areas are well suited to cotton and cereals. Cotton yields from one-third to 1 bale per acre, wheat from 15 to 25 bushels per acre, and oats from 20 to 30 bushels per acre. Corn is best suited to the lower lying, darker soils in the basins, yielding from 25 to 30 bushels per acre. Although cotton produces a rank growth in these basins, the bolls often fail to mature. Where cotton is allowed to make a stand in these areas, attention should be given to "chopping," so as to give the individual stalks more space in which to mature their fruit. Wheat was grown quite extensively upon this soil when it was first cleared, but for more than half a century cotton and corn have been the staple crops, and in some instances cotton has been grown almost exclusively. Besides the crops above mentioned this soil would be well suited to stock raising and dairying, as Johnson and Bermuda grasses and other forage crops, such as cowpeas, vetch, clover, etc., do well. Many large springs have their origin in or near bodies of Decatur clay loam, and with the large creeks in close proximity or passing through these areas there is an assurance of plenty of water for stock the year round.

This soil is largely leased to tenants whose contracts expire after the crop is made, and it is the exception to find one who remains longer than one or two years upon the same tract of land. Cotton is usually stipulated as the basis for rental, so that crop rotation is not generally encouraged. Where the soil is handled by the owner, more attention is usually given to tillage and to the rotation of crops, the result being that within a few years the yields are frequently doubled. With better methods of seed selection, proper rotation, and the addition of sufficient humus, the soil should yield on an average 1 bale of cotton per acre and from 40 to 60 bushels of corn.

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By the addition of organic matter the benefits resulting from the use of commercial fertilizer would be increased, as these give their maximum returns only when the soil is well stocked with humus.

This type is not generally listed on the markets, but when offered for sale it brings from $15 to $40 or $50 an acre, depending on the location and improvements.

The following table gives the results of mechanical analyses of samples of both soil and subsoil of the Decatur clay loam:

Mechanical analyses of Decatur clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
20159	Soil	0.4	6.6	5.4	12.9	23.3	31.3	19.7
20160	Subsoil	.3	4.5	4.1	8.7	15.9	27.7	38.3

DECATUR STONY LOAM.

The interstitial material of the soil of the Decatur stony loam consists of a brownish or reddish fine sandy loam, or loam having an average depth of about 6 inches, but varying from 4 to 8 or 10 inches in depth. The surface soil is usually quite dark. The subsoil is a dark-red or brick-red sandy clay. The color is generally more pronounced and the texture heavier in the lower depths. Scattered over the surface and throughout the soil and subsoil are varying quantities of subangular and angular chert, quartzite, and sandstone fragments, but these rarely interfere seriously with cultivation.

The Decatur stony loam is one of the most widely distributed types in the area. It is extensively developed in the vicinity of De Armanville. It also occurs near Oxford, Anniston, Bynum, Weavers, Jacksonville, Piedmont, White Plains, Ironcity, and in smaller areas in almost every section of the county.

This type is derived largely from the residual materials left after the solution and disintegration of impure limestones, chiefly the Knox dolomite and to some extent from formations belonging to the Subcarboniferous. Some shale has also entered into its composition. Where this type occurs in the vicinity of Coldwater and Choccolocco Mountains, displaced materials have entered largely into its origin, as is shown by the occurrence of rounded sandstone and quartzite bowlders throughout the soil profile. This phase of the type probably represents materials of both sandstone and limestone origin, and is closely allied to the Upshur stony loam, as mapped in other areas.

The Decatur stony loam usually occupies the lower slopes and foothills of the mountains. It also occurs as isolated ridges, hills, and

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table-lands throughout the broader valleys. Its topography in some instances is similar to the Decatur loam and clay loam, but for the most part it is hilly and broken or eroded. The drainage is sometimes excessive, and it is always sufficient for seasons of average rainfall. Very little of the type requires artificial drainage. The stones in the soil act as a mulch to conserve the moisture, so that it does not suffer from drought, as do the heavier equally well drained soils.

The native vegetation upon this soil type consists of longleaf and shortleaf pine, hickory, white, red, and black-jack oak, persimmon, dogwood, chestnut, and various species of shrubs. The marketable lumber has practically all been removed and a large percentage of the type has been cleared and is under cultivation. It is classed with some of the most productive soils in the area, and is especially well suited to cotton and fruit culture. Cotton yields from one-half to three-fourths bale per acre, and with the use of fertilizers corn yields from 10 to 20 bushels per acre and oats from 20 to 40 bushels per acre. Clover does well also. Alfalfa has been tried with some success, but generally not enough attention has been given to this crop to make the test effective. Liberal applications of lime and a thorough preparation of the seed bed are essential to the successful culture of alfalfa upon this soil. The type is well suited to peaches, blackberries, raspberries, currants, gooseberries, and plums; also to the usual truck crops. The lighter soils on the lower slopes of the mountains are best suited to peaches, which are especially valued for their high color and fine flavor, but thus far very little attention has been given to this industry upon a commercial scale. The trees usually not being properly cared for, become diseased, and in a short time the entire orchard is infected. What fruit is grown is disposed of in the local markets, and in many instances no provision is made to supply home needs. The introduction of home canneries would encourage the growing of more fruit.

This land is valued at $8 to $20 an acre, depending, of course, on the location and nearness to markets.

The results of mechanical analyses of fine-earth samples of the soil and subsoil of this type are shown by the following table:

Mechanical analyses of Decatur stony loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
20165	Soil	0.5	8.1	7.3	24.5	13.1	26.4	19.5
20166	Subsoil	1.1	5.9	5.5	15.7	13.5	25.2	32.9

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DECATUR LOAM.

The surface soil of the Decatur loam is a brown, medium-textured, sandy loam, or light loam, or a silty to fine sandy loam, varying in depth from 4 to 8 inches, with an average depth of 7 inches. The soil generally is quite uniform in texture, and the color becomes more reddish in the lower depths. The subsoil is a reddish sandy clay or clay loam, which in the lower depth is very dark red, being similar to the subsoil of the Decatur clay loam, and where erosion occurs it has a spotted appearance. A few areas of dark-brown silt loam, underlain by a deep-red silty to fine sandy clay, are included with this type. These occur in close proximity to the Montevallo shale loam.

This type is widely distributed over the county, but does not occur in large areas. It is found in the vicinity of Tredegar, Piedmont, Anniston, Alexandria, and in smaller areas in all the larger limestone valleys. The surface features are moderately rolling and the drainage excellent. The sandy nature of the soil, acting as a mulch, retains the moisture, and crops suffer little from drought, and better returns are shown from the use of commercial fertilizers.

The Decatur loam is derived largely from the solution and disintegration of limestone. The occurrence of rounded quartzite and sandstone pebbles upon the steeper slopes and knolls would indicate that a portion of the soil either represents materials reworked by water and spread over the surface or derived from the breaking down of a conglomerate.

The native vegetation consists of longleaf pine, oaks, persimmon, etc. Most of this type is cleared and under cultivation. It is well suited to both corn and cotton, and produces from one-third to 1 bale of cotton per acre and from 15 to 20 bushels of corn per acre. It is one of the easiest soils in the area to cultivate, but it is seldom plowed deep enough. Large yields of cowpea hay are produced, which net good returns, besides enriching the land. This practice should be extended. It is also well adapted to stock raising, dairying, fruit growing, and trucking—tomatoes, peas, beans, cantaloupes, and Irish and sweet potatoes doing especially well. Clover also does fairly well. Very little attention is given to the growing of winter cover crops, which would prevent washing during the rainy seasons, besides furnishing winter pasture.

This soil is highly valued for general farming purposes, and is not generally for sale, but its estimated value is from $12 to $25 an acre.

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The results of mechanical analyses of samples of the soil and subsoil of the Decatur loam are shown by the following table:

Mechanical analyses of Decatur loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
20153	Soil	0.9	8.5	5.7	13.2	10.9	47.1	13.5
20154	Subsoil	.8	5.1	4.2	8.3	12.9	35.9	32.8

MONTEVALLO SHALE LOAM.

The fine earth of the Montevallo shale loam is a purplish to brownish floury, silty loam, varying in depth from 5 to 10 inches, with an average depth of 6 or 7 inches. Upon the surface and throughout the soil profile occur varying quantities of sandstone and variegated shale fragments, the latter being one of the distinguishing features of the type as well as the source of its local name, "slaty land." The subsoil varies from a purplish to a brownish silty clay or clay loam to a mass of weathered shale, which is usually variegated, a purplish coloring predominating.

The largest connected areas of Montevallo shale loam occur in the vicinity of Weavers Station. Other areas occur in the vicinity of Piedmont, Jacksonville, Anniston, Bynum, Coldwater, and north of Alexandria, while smaller ones are scattered throughout the county. This type is generally found in close proximity to the limestone soils of the valleys.

The topography is generally hilly to mountainous, consisting of elongated ridges, with comparatively steep slopes, sharp crests, and narrow intervening valleys. The streams are mostly intermittent, and the drainage is usually excessive. Because of the loose structure of the soil, it easily erodes, and terracing must be done when the type is cultivated. Even this does not prevent frequent losses on the steeper slopes by erosion, and many of the cleared fields have to be abandoned for this reason. The growing of winter cover crops and deeper plowing in the fall will lessen the tendency to wash. The steeper slopes should be kept in forests and used for grazing.

The Montevallo shale loam is derived from the weathering of the sandstones and variegated shales of the geological formation known as the "Montevallo" of the upper Subcarboniferous. These shales rarely occur horizontally bedded, but are inclined at angles of 30° to 50°, and upon weathering surface exposures of the various strata give rise to wide variations in texture and color, as represented by the different phases of this type. Where the thicker banded, coarser grained sandstone shales outcrop the residual material is lighter colored and

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coarser, and angular fragments or sandstone blocks are scattered more thickly over the surface. These are highly ferruginous, and vary in color from light brown to deep purplish red or brownish. The thin-banded, finer textured shales are usually more variegated or purplish. Upon weathering these break down into thin scales, and frequently compose the greater proportion of the soil mass where this formation comes close to or outcrops at the surface. The variegated shales and sandstones of this formation are frequently underlain by blue limestone, which no doubt gives rise to the heavier purplish-red subsoil found upon the lower slopes and in narrow valleys between the ridges. These are the most highly prized areas of the type for general farming. They are not only more fertile, but are less liable to erode and are comparatively free from rock fragments.

Only a limited acreage of this type is under cultivation, the greater proportion supporting a native forest growth of longleaf and shortleaf pine, and various kinds of oak, hickory, dogwood, cedar, chestnut, etc. The best timber, however, has been removed. The rougher portions are of very little value aside from their timber and mineral resources. The occurrence of iron ore in some sections of the county in connection with the Montevallo formation was noticed. When the slopes are not too steep they furnish fairly good range for stock. The lower slopes and valleys, when cleared and cultivated, produce from one-fourth to one-half bale of cotton per acre and from 10 to 25 bushels of corn to the acre. Cotton is usually planted on the better drained slopes, while corn is planted in depressed basins. The growing of cowpeas, clover, rye, vetch, and oats for hay and grazing, as well as for plowing under as a green manure, should receive more attention.

The Montevallo shale loam is valued at from $8 to $15 an acre.

The results of the mechanical analyses of samples of the soil and subsoil of the Montevallo shale loam are as follows:

Mechanical analyses of Montevallo shale loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
20193	Soil	2.3	3.0	0.6	3.6	33.5	44.7	12.0
20194	Subsoil	1.0	1.8	.8	3.3	28.6	36.5	27.8

ROUGH STONY LAND.

The type Rough stony land includes steep escarpments, precipices, and deeply eroded ravines and cuts; also the less steep slopes and mountain tops, the surface of which is covered with rock fragments and rock outcrop. The type ranges in elevation from about 1,000 feet to something over 2,000 feet above sea level, or from 300 to 1,500 feet above the valley lands of the county.

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The processes of erosion are so active that it is possible for a deep covering of soil to accumulate only on areas of very limited extent. The finer soil, or interstitial material, is so variable that only a general classification can be made, the larger percentage of it being sandy. Where these rough stony areas are associated with the Clarksville stony loam, the soil is more silty. The color of the soil is generally dark gray to brown and yellow to reddish in the lower depths.

As the soil is never very deep it is rarely possible to bore to a depth exceeding 8 or 10 inches. Small areas occur throughout this type upon the flattened hilltops and in basins where the soil is deeper and comparatively free from stones and rock outcrop, but owing to the rough, broken character of the country it was impracticable to separate them. Where accessible such areas could be used for growing fruit, especially peaches and grapes. A few areas of a rich dark loam, mapped in other sections of the Appalachian Mountain province as Porters black loam, were encountered in the smaller coves and depressions. This soil is especially adapted to apples, particularly the Albemarle pippin. Fruit trees planted upon such areas on the mountains rarely fail to make a crop. With the increased demand for fruit in the local markets and abroad, and with the increase in value of the more accessible land, these areas may be used later for commercial fruit growing. This type is also used to some extent for pasture, and its use in this way could be greatly extended, especially for sheep and goats.

The occurrence of this type is due mostly to the presence of sandstone conglomerates and quartzite strata together with other resistant formations, which have given rise to the rougher and more prominent topographical features of the country.

Rough stony land occupies about 66.2 square miles, or 10.7 per cent of the area surveyed. The largest continuous area includes the higher, stonier, steeper, and more rugged portions of the Choccolocco range of mountains and extends in a general northeast and southwest direction across the eastern half of the county from near Oxford to within a short distance of Piedmont. The next largest area includes similar conditions upon Coldwater, Dugger, and Blue mountains. Narrow strips of this type form a portion of the boundary between Calhoun and Etowah counties. Other areas occur throughout the more broken sections of the county.

This type is excessively drained, and during the rainy seasons it is seriously eroded by mountain torrents if left unprotected by the removal of the timber growth. The native vegetation was originally thickly timbered forests of longleaf pine, chestnut, oak, etc., but in recent years most of the marketable timber has been removed. Forest fires have also destroyed much of the timber. The present growth is scant and largely oak, shortleaf pine, hickory, chestnut,

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etc. No better use could be made of this land than for forestry, especially since it is usually held intact in large areas by mineral land companies, the "pockets" of iron ore scattered throughout it yielding a large revenue to the owners.

The valuation placed upon this soil type is based almost entirely upon the extent of its timber growth and mineral resources. Only a very limited acreage is under cultivation. It is usually sold without the mineral rights at from $2 to $5 an acre.

CLARKSVILLE STONY LOAM.

The soil of the Clarksville stony loam, from 6 to 10 or 12 inches deep, with an average depth of about 8 inches, consists of a gray, brown, or drab silt loam or silty to fine sandy loam, containing varying amounts of chert and siliceous rock fragments throughout the soil profile and upon the surface. The soil in the lower depths is of a yellowish-gray color. The subsoil to a depth of 15 or 18 inches is a compact heavy loam or silt loam, grading into a silty to fine sandy clay or clay loam. The lower subsoil is usually characterized by a deepening of the yellow or reddish-yellow color and iron stains which occur in streaks throughout the profile, frequently giving it a mottled appearance. The occurrence of partially disintegrated limestone, in the lower depths, produces a "whitewashed" effect upon exposure in road cuts, excavations, etc. It is frequently referred to locally as "white land," "mulatto land," "gray land," "piney woods land," etc.

This soil has usually a low humus content and when cleared and put under cultivation must be fertilized after the second or third year. The occurrence of a large amount of rocks and chert fragments upon the surface and in the soil interferes to a considerable extent with cultivation. Its steep broken surface features also make it as a whole undesirable for general farming purposes. The talus slopes and more undulating portions of the type are, however, being cleared and put under cultivation, and it occasionally happens that there are areas which are comparatively free of rock fragments. Where such areas occur in large enough bodies to warrant their separation they were included with the Clarksville gravelly sandy loam.

The Clarksville stony loam is one of the most extensively developed types in the area. It occurs mainly in two large irregular bodies, one in the north-central portion of the county, west of Piedmont, and the other lying north and west of Anniston, in the southern and southwestern portions of the county. These two areas are separated by a more complicated series of soil conditions in the central portion of the county in the vicinity of Alexandria. Several minor ridges of the type dissect this part of the county, having a general northeast and southwest direction. Other smaller disconnected areas occur throughout the county, chiefly in the northern and western parts.

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The native vegetation consisted chiefly of a fine growth of longleaf pine, but in recent years most of this has been "logged off," leaving a second growth of pine, black-jack, and scrub oak, and some chestnut.

The Clarksville stony loam is derived very largely from the weathering in place of the Knox dolomite formation. This consists of cherty limestone rock from which the calcareous material becomes dissolved or leached out, leaving the hard, flinty material which imparts to the soil its stony, gravelly character. The occurrence of crinoidal stems and other fossiliferous remains were observed in the formation. The residual materials of the Knox dolomite formation, including the chert fragments, are being used extensively throughout the county for surfacing roads, with excellent results. This practice should be extended. Several lime kilns are located in the section covered by this formation and the limestone is being burned for commercial purposes.

The Clarksville stony loam is well drained. In many instances, however, the drainage is excessive, in which case the soil washes badly. For this reason the steeper slopes should be devoted to forestry or seeded down to permanent pasture and more attention given to terracing. The light character of the subsoil makes it generally susceptible to drought, but the rock fragments upon the surface tend to conserve the moisture. Heavy rains cause this soil to run together where it occurs upon the more level areas.

This type usually occupies steep, broken, or choppy ridge land. The broader areas have the appearance generally of rough dissected plateaus, with irregular ridges and narrow V-shaped and precipitous valleys, having a mean difference in elevation of 250 to 300 feet. The streams are generally intermittent, although some of the finest springs in the county have their source on this type.

The Clarksville stony loam is mostly broken with a one-horse turning plow. It is better suited to corn than cotton, the former yielding from 20 to 40 bushels per acre. Cotton yields vary from one-fourth to one-half bale per acre without the use of fertilizers, but after the third year the low returns make it necessary to apply them. If cowpeas and corn were rotated with cotton less fertilizer would be required to maintain the yields, or they could easily be increased. This soil is also well adapted to wheat, yielding from 10 to 40 bushels per acre, averaging 15 to 20 bushels. The acreage of wheat has been greatly reduced in the last few years. Wheat should be sown in October, if possible, or at least by the 1st of November. The tendency at present is to follow a one-crop system of either cotton or corn. Every farmer upon this type seems to recognize the value of planting cowpeas as a soil builder, but few practice it. If more stock were raised the demand for feedstuffs would encourage the growing of cowpeas for hay. Clover does

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fairly well upon this soil and should be grown more extensively. A very good grade of tobacco is grown, but none of it is marketed. The lower lying areas are well adapted to apples, plums, pears, small fruits, and vegetables, including Irish potatoes. Where the topography makes it suitable for the production of apples and peaches their cultivation is usually attended with profitable results, if accessible to markets. This type is especially adapted to peaches, and if more attention is given to developing a canning industry in the county a profitable business in peach growing could be developed. The lack of market facilities discouraged the growing of peaches in the last few years, and many fine orchards have been allowed to go to ruin for lack of attention.

Most of this type is held in large tracts by mineral land companies, who frequently sell the land but retain the mineral rights. Fairly rich deposits of limonite ore occur throughout the type, and its present valuation is based largely upon its mineral prospects, timber, and use as pasture. It is generally valued at from $3 to $10 or even $20 an acre.

The results of mechanical analyses of fine-earth samples of the soil and subsoil of the Clarksville stony loam are shown in the following table:

Mechanical analyses of Clarksville stony loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19119	Soil	5.2	8.3	3.9	9.3	5.2	54.0	13.1
19120	Subsoil	4.0	7.9	3.9	9.2	4.9	53.0	18.0

CLARKSVILLE GRAVELLY SANDY LOAM.

The soil of the Clarksville gravelly sandy loam is a dark-gray or light-brown silty loam or fine sandy loam from 6 to 12 inches deep, with an average depth of 8 inches. The soil contains, in addition to the fine-earth material, a rather high percentage of small chert and shale fragments, but only a few of these were large enough to be classed as rocks or bowlders. The chert fragments occur chiefly upon the ridges and knolls, while the narrow valleys and depressions are comparatively free from them. The subsoil to a depth of 15 or 20 inches is a grayish to yellow heavy loam or clay loam underlain by a yellow or reddish silty clay, the latter occurring upon the knolls and ridges, while the yellow subsoil is more often associated with the flat or depressed areas.

Although this type covers but a few square miles it is widely distributed over the county. It generally represents the level to gently rolling "gray lands" which occur as talus slopes or basins

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in the Clarksville stony loam. A few isolated areas, however, were mapped in the valleys, but these were not associated with the stony loam type. The largest single area occurs about 3 miles northwest of Piedmont and extends to the Cherokee County line. Other small areas were mapped along the route of the Seaboard Air Line from Piedmont to Wellington. An elongated area covering a little more than 1 square mile occurs about 3½ miles southwest of Alexandria. Areas of less extent are found in the vicinity of Mink, De Armanville, and Bynum, and elsewhere throughout the county.

The surface topography is flat to moderately rolling, usually occupying the lower hills and slopes of the broken areas covered by the Clarksville stony loam. The type is generally well drained, with the exception of the smaller depressions and narrow winding valleys which receive the drainage from the higher elevations. These areas, however, are usually drained by open ditches and are mostly used for the production of corn, sorghum, hay, or pasture. Upon the steeper slopes the soil is easily eroded and must be terraced when used for general farming. A better use of this phase of the type would be to sod it in Bermuda or orchard grass for hay or pasture. Cotton does fairly well on these slopes, but on account of their location the soil washes badly, carrying away the fertilizer and making it an expensive crop to cultivate. Corn yields from 10 to 15 bushels per acre, but it is more often grown upon the flat or depressed areas, where larger yields are obtained.

The native vegetation consisted largely of longleaf and shortleaf pine, oak, hickory, dogwood, and other deciduous trees. Most of the land, however, has been cleared and is under cultivation. On account of its gently rolling surface and its position upon the slopes and in basins and valleys it is better suited to general farming than the Clarksville stony loam, and it is easier to cultivate, being comparatively free from rocks and bowlders. It is more susceptible to drought than the stony loam and is also more affected by periods of wet weather.

This type is especially adapted to apples, plums, pears, raspberries, strawberries, blackberries, and other small fruits and vegetables. It is well suited both to Irish and sweet potatoes, yielding from 75 to 100 bushels or more per acre. Oats, wheat, rye, and barley also do well, but these have not been grown to any extent in recent years. More attention is given to oats, which are usually sown in October, than any other small grain. After these are harvested in the spring they should be followed by cowpeas, grown either for hay or to be turned under to supply the soil with humus. Rye with vetch or crimson and burr clover would also make excellent winter cover crops. Some difficulty might be experienced the first year in obtaining a stand of clover without inoculating the soil, but if repeated for

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a year or two the clover itself would eventually inoculate the land and produce large yields of hay and also make excellent pasture. This type is especially adapted to sorghum, from which a very fine light-colored and mild-flavored sirup is obtained. This soil is probably best suited to corn. Yields of 10 to 25 bushels per acre are obtained by the use of fertilizers, which are generally applied at the rate of 200 pounds to the acre. Cotton yields on an average from one-fourth to one-third bale per acre. A few small patches of tobacco were observed upon this type, but it is grown exclusively for home use. This industry can be profitably extended if its culture is given sufficient attention to command a market. Where this type occurs in the vicinity of railway stations, towns, or cities it will probably yield larger returns from dairying, trucking, and fruit growing than from general farming. It is well suited to Bermuda grass, which makes an excellent hay crop and pasture. Running water is generally found in the valleys throughout the year, making it suitable for stock raising.

The Clarksville gravelly sandy loam is generally valued at $5 to $15 an acre. It is often held in conjunction with other types in large tracts by the mineral land companies, who dispose of the agricultural rights but retain the mineral rights.

The results of mechanical analyses of fine-earth samples of the soil and subsoil of this type are shown in the following table:

Mechanical analyses of Clarksville gravelly sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
20141	Soil	2.7	15.1	12.6	20.6	7.6	29.5	11.5
20142	Subsoil	2.6	13.4	12.3	21.3	8.3	26.6	15.3

CLARKSVILLE LOAM.

The soil of the Clarksville loam from 6 to 10 inches in depth, with an average depth of 8 inches, is a dark-gray to brown loam, resting upon a grayish to light-yellow clay loam 18 to 20 inches deep, which in turn is underlain by a bright yellow or reddish clay.

This type is of limited acreage in the county and occurs chiefly around Mink, and about 3 miles north of Zula. Smaller areas occur in the southern portion of the county, where they join the same type of soil mapped in Talladega County.

The surface features are flat to gently rolling. The drainage is usually adequate for most crops during seasons of average rainfall, but in wet seasons crops are frequently damaged by rust and standing water.

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The Clarksville loam is derived from siliceous limestone of the Knox dolomite formation. It is comparatively free from chert fragments, which formed the basis of separation between this type and the Clarksville gravelly sandy loam. In the lower lying areas the soil has been formed partially by wash from the surrounding hills of the Clarksville stony and gravelly sandy loam, but usually these areas are of very limited extent and are used mostly for corn. Apples, plums, and pears also do well upon these low places. The soil is probably best suited to grasses, such as Bermuda, orchard, and Johnson grass, for pasture and hay. Clover does fairly well and is grown to some extent. Very little cotton is grown upon this type, but a few small patches of tobacco for home use were observed.

This land is valued at $5 to $15 an acre according to location.

DEKALB LOAM.

The surface soil of the Dekalb loam to a depth of 4 to 9 inches, with an average depth of 7 inches, is a light-brown or grayish loam or silty loam, containing sufficient gravel and sand of various grades to make it "gritty." On the knolls the soil is often not more than 3 or 4 inches deep and frequently small patches of shale outcrop appear. The subsoil is a yellow or reddish clay loam 12 or 15 inches deep, underlain by a brownish or reddish stiff mottled clay. The subsoil is usually stiffer, more plastic, and of a darker red color upon the knolls, where the soil is better drained, while on the slopes and in the depressions it is more often yellowish and of a lighter texture or less plastic.

The Dekalb loam occurs chiefly in the northern and western portions of the county in irregular broken areas. The greater proportion is found in the Coosa Valley proper, associated with the Dekalb shale loam and other Dekalb and Holston soils. It is found in the vicinity of Piedmont, Jacksonville, Weaver, Alexandria, and Ohatchee. The largest body occurs about 4 miles northwest of Wellington.

The surface relief of this type is gently undulating to rolling. The drainage is ample upon the ridges and knolls, but it is lacking in the narrow valleys or depressions which receive the drainage waters from the more elevated areas. These, however, can easily be drained by open ditches leading into the deeper cuts and gullies that form the stream beds. The level areas are sometimes damp and cold, except in dry seasons, when the soil suffers from drought so that crops are often late in starting. If the ridges and knolls have steep sides they are inclined to erode, even when terraced, and they should be kept in forest growth or sodded with Bermuda or Johnson grass. They should never be left without some protecting crop in winter to prevent washing.

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This type is derived from the weathering of yellowish to gray argillaceous shales, sandy shales, and fine-grained sandstones, which occur in alternate layers and outcrop at various angles to the surface. When the shales appear perpendicularly at the surface they are usually shattered off into flakes, forming the shale loam. On the sides of the slopes the soil is generally deeper, unless acted upon by erosion. In this case the flat or depressed areas receive the deposits of sediment washed from the slopes. Some of this type may have been derived from the weathering of siliceous limestone or dolomite, since fragments of chert are occasionally found upon the knolls. The shales usually occur embedded at depths varying from 3 to 6 or 8 feet, as shown by road and railroad cuts.

In the vicinity of Wellington and occupying little more than 1 square mile the soil varies somewhat from the typical description. Here the immediate surface soil is a dark-brown loam, grading into a light shale loam at 30 to 36 inches. The subsoil is generally mottled in the lower depths. Occasionally the partially weathered rotten shales are encountered at a depth less than 3 feet, but generally these occur at from 5 to 6 feet, or more, below the surface. This phase of the type is derived from the weathering of dark-brown to black, thinly laminated, fine-textured, rotten shales. The bedding plane of these shales rarely occupies a horizontal position, being slightly inclined to almost perpendicular.

The Dekalb loam is generally called "post-oak land," from the large number of trees of this species that grew upon it. Longleaf and shortleaf pine, black-jack, sweet gum, and other deciduous trees and shrubbery were also original growths. Broomsedge produces a rank growth in abandoned fields.

This is an easy soil to cultivate where the moisture conditions are favorable, but if plowed when wet it clods and does not scour easily. The best returns are obtained by the use of the revolving disk plow, the soil being turned in the fall or early winter. The tendency of the soil to run together could be remedied largely by the turning under of legumes and winter cover crops. This would not only increase the supply of humus, in which the soil is generally deficient, but would also conserve the moisture and prevent washing.

For the first two or three years after the soil is put under cultivation very good yields of cotton and corn are obtained, but the yields rapidly diminish after the third year unless the crops have been grown in rotation and commercial fertilizers have to be applied to maintain the productiveness. Wheat and oats do well upon this type, especially upon the highly fertilized areas which had been previously planted to cotton or corn. The yields of wheat range from 20 to 30 bushels per acre and of oats from 30 to 50 bushels per acre. Very little wheat is at present grown, having been abandoned in recent years on account of rust. Where it is possible to grow it, this crop

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should be included with other crops in rotation with corn and cotton. Deeper plowing is generally needed so that the crops will not be so susceptible to drought, while shallow and frequent cultivation will help to conserve the moisture already taken up by the soil. Barnyard manure, usually in the form of compost with pine straw and cotton seed, is used to some extent, but the supply is never sufficient and commercial fertilizers have to be added. Cowpeas make a vigorous growth, especially when fertilized with phosphate, and yield from 1 to 2 or more tons per acre. The value of cowpeas as a soil builder is quite generally recognized, but on account of the land being rented to tenants very little cowpea hay is made. Sorghum does especially well in the lower lying areas having light-colored subsoils, producing a sirup of light color and high quality. Raspberries, blackberries, strawberries, apples, plums, pears, and grapes do fairly well. The pears blight, but this disease may be kept in check by proper spraying and vigorous pruning of the trees. Large tracts of this land have been allowed to remain idle for lack of labor to tend the crops. If these areas were sodded down in Bermuda or Johnson grass and cut for hay, using improved machinery to handle the crop, they could be made to yield profitable returns with but little labor and attention and at the same time they would furnish excellent pasture. The fields would also be protected from erosion, which is causing serious damage. Corn and cotton are the principal crops grown. The former yields from 10 to 20 bushels per acre, while cotton yields from one-fourth to one-half bale per acre.

The farmhouses on this type are frequently two-roomed structures made of logs or rough siding. The outbuildings are of the same general character, being made of poles covered with clapboards. The farms, if fenced, are usually inclosed with rail fences, although wire fencing has come into use in some sections within the last few years. The scarcity of labor and the desire for better school facilities have caused some of the farmers to desert their farms and move to town, where they obtain employment upon public works or in the factories.

This soil type is valued at $5 to $15 an acre.

The results of mechanical analyses of the soil and subsoil of this type are shown in the following table:

Mechanical analyses of Dekalb loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
20171	Soil	7.1	12.5	4.9	11.4	11.2	41.7	10.7
20172	Subsoil	4.5	7.4	3.1	6.6	7.3	37.5	33.6

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DEKALB SHALE LOAM.

The soil of the Dekalb shale loam is a brown to yellowish loam or heavy silty loam 6 to 8 inches deep. On the slopes where the shales are lighter in color and coarser in texture the soil is more sandy, while on the sheltered slopes and in depressions where the flaky brown shales prevail the soil is deeper and more silty. The subsoil consists of a heavy yellow to reddish clay loam, the clay content sometimes increasing with depth to 18 or 24 inches where the less disintegrated shale mass is encountered. In the more level areas a stiff rather plastic clay overlies the shales.

Upon the surface and scattered throughout the soil and subsoil are found shale fragments which increase with depth, the subsoil always resting upon the underlying broken shale. Where the steeper slopes occur the soil is removed nearly as rapidly as it is made, the remaining formation being nothing more than a mass of weathered or broken shales. The texture of the soil of the large, unbroken area of this type which occurs in the southwestern part of the county is considerably coarser than the interstitial material of other areas of this type. This is due to the fact that the shales from which this area is derived are of the quartz-veined phase of the Conasauga or Flatwoods shales. The soil in this section is thinner and lighter than in any other part of the county.

In the northwestern part of the area, parallel to the Green Mountain range, a steep broken phase of the Dekalb shale loam is found having a brown silt loam soil 6 to 8 inches deep. The subsoil is a yellowish-brown fine sandy loam to 24 inches, where unbroken shales are usually encountered. The surface is covered with flat brown flagstone shales or shales of a fine sandy texture about one-half to 1 inch in thickness.

The Dekalb shale loam occurs in this county usually in bodies varying from small patches to areas of 1 to 3 square miles in extent. The largest continuous body of this type occurs in the southwestern part of the county along the Coosa River and extends from Fombys ferry to the intersection of the Talladega County line. The next largest area occurs around Sulphur Springs Church, about 1½ miles northeast of Alexandria. Other areas are found near Francis Mill, Boiling Spring Church, and Ohatchee. Smaller patches are scattered over the western half of the county.

The topographic features of this type, like those of similar shale formations, consist of a series of rounded hills or knolls of fairly uniform height, with sloping sides and smooth contour lines. Between these hills or knobs are narrow winding valleys, which are usually dry except in wet seasons, and very little bottom land is found along the streams. The phase of this type lying parallel to

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Green Mountain presents a much steeper and more rugged topography than is common to this type in other sections of the county. It occurs in long, narrow, steep ridges.

The hilly topography and the steepness of the slopes afford rapid removal of the water from the soil and subsoil. In most cases the subdrainage of the Dekalb shale loam, owing to the presence of shale fragments, is excessive, causing the soil to be droughty.

The Dekalb shale loam is a residual soil derived from the underlying shales. These shales vary from argillaceous to sandy, are thin to thick bedded, and more or less calcareous. During the uplifts and subsidences which occurred the valley formations were turned end upon end and were greatly distorted and shattered. The processes of weathering have been carried on both by chemical and physical forces to a considerable depth. The surface features produced by the distortion of this formation are such as to cause the removal of much of the weathered material as soon as formed. Where conditions are such that there is a chance for accumulation, the complete weathering of the shales results in a heavy yellow clay.

The native vegetation upon this type generally consists of scrub pine, chestnut, and scrub post oak. From the last-named timber growth the type gets the name "post oak slaty land" by which it is generally known. The principal crops are corn and cotton. Wheat was grown upon this type until four or five years ago, when it was practically abandoned on account of rust. The average yield of wheat was from 8 to 10 bushels per acre. Cotton does fairly well, yielding from one-fourth to one-third bale per acre with the use of commercial fertilizers. For the first few years after this type is cleared this yield is obtained without the use of fertilizers, but the humus is soon leached out and the yields rapidly decline. Corn yields from 8 to 10 bushels per acre with the use of fertilizers. The coarse texture and droughtiness of the soil make it a poor one for corn. Almost no attention is given to crop rotation upon this type.

The steeper slopes should be reserved for forestry or planted to grasses for grazing or hay. Cowpeas grow well, and in addition to producing fair yields of hay they build up the soil very materially. Lime would be beneficial, but none is used. Deep plowing is recommended, as it enables the crop better to withstand drought. Conditions would be greatly improved if more live stock were raised and the manure produced turned back into the soil. The turning under of green manure would also greatly improve the physical conditions, increasing the moisture-holding capacity.

The farmers living on the "slate lands," as this type is locally called, are not as prosperous as those on some of the more productive soils. The houses often consist of two-room log or frame buildings. The barns and other outhouses are usually built of pine poles. The

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fences are frequently in poor condition, but this is sometimes due to the scarcity of timber from which to obtain posts and rails. Many farms have been abandoned within the last few years, the owners moving into the larger centers of population to work in factories. The fields are often allowed to grow up in broomsedge, field pines, etc., and where this protection is inadequate to hold the soil together erosion often follows with serious results.

The farms usually contain about 40 acres and as a rule are valued at from $6 to $15 an acre.

The following table gives the average results of mechanical analyses of the soil and subsoil of the Dekalb shale loam:

Mechanical analyses of Dekalb shale loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19831, 20179.....	Soil.....	10.1	13.5	5.1	10.3	10.2	36.5	14.1
19832, 20180.....	Subsoil.....	6.0	9.0	3.3	6.7	7.9	31.4	35.7

DEKALB STONY LOAM.

The soil of the Dekalb stony loam consists of a grayish or brown fine sandy to silty loam, or sandy loam, varying in depth from 5 to 12 inches and having an average depth of about 6 inches. It is underlain by a yellow to reddish heavy sandy loam or sandy clay subsoil. Upon the surface and scattered throughout the soil and subsoil are varying quantities of sandstone fragments and conglomerate.

The type occupies mainly the lower slopes and foothills of the Coldwater Mountains west of Oxford and the Choccolocco Mountains, extending from Anniston to Piedmont, and irregular broken areas along both slopes of this range. It also occurs along a part of the northern boundary of the county, and another area of considerable extent is found in the northwestern part of the county, about 2 miles north of Ohatchee. Smaller areas occur in other parts of the county.

The surface of this type is usually rough and broken and badly dissected by erosion, but upon the talus slopes the surface is more gently undulating and better suited to agriculture. The drainage is usually excessive, except upon the lower slopes, where it is adequate for all purposes. The streams are mostly intermittent, but during the rainy seasons they become very rapid and gushing, since they serve to give outlet to the mountain torrents.

The Dekalb stony loam is derived from the weathering of the Weisner sandstone and conglomerate and coal measures, which occur in the northwestern portion of the county.

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This type formerly supported a heavy growth of longleaf pine, but the greater percentage of it has been cut for lumber or burned by forest fires. The more recent growth consists of shortleaf pine, black-jack, hickory, and red and white oak.

The Dekalb stony loam is not generally suited to agriculture, though it may be used for grazing, but upon the lower slopes some fields have been cleared which produce fairly good yields of cotton and corn, being best suited to the latter. The largest area under cultivation occurs along the border of the mountains, between Oxford and White Plains, where the slopes are longer and admit of easier cultivation. This soil is well suited to peaches, yielding fruit of excellent color and flavor. Very little attention, however, is given to pruning and spraying. The soil is also well suited to trucking, especially watermelons, cantaloupes, cucumbers, peas, beans, and potatoes.

This type is naturally well supplied with humus from the decay of leaves and other forest vegetation, but after it is cleared and put under cultivation the humus is rapidly consumed or leached out and commercial fertilizers have to be used. The growing of legumes, including cowpeas, velvet beans, clover, rye, and vetch, would assist in maintaining the supply of humus, and deeper plowing is also needed. The rougher areas should be kept in forest and used for grazing purposes. Land of this type is valued at from $5 to $20 an acre, depending upon the location.

The following table shows the average results of mechanical analyses of the soil and subsoil of the Dekalb stony loam:

Mechanical analyses of Dekalb stony loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
20173, 20177	Soil	1.7	7.1	7.3	24.9	15.8	27.8	15.5
20174, 20178	Subsoil	1.5	5.6	3.0	20.1	17.2	27.6	24.3

DEKALB SANDY LOAM.

The surface soil of the Dekalb sandy loam is a dark-gray or brown medium sandy loam, having an average depth of about 8 inches. The color becomes lighter or more yellowish below 2 or 3 inches, as the amount of organic matter present in the soil becomes less. Small patches of gravel and stones occur throughout the type, but not in sufficient numbers to interfere with cultivation or to warrant establishing a distinct soil. The subsoil is a yellowish to yellowish-red heavy sandy loam or sandy clay. In some instances it has a distinctly red color in the lower depths.

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The Dekalb sandy loam is an easy soil to cultivate. Having a loose, open structure, it is always well drained, but it is not droughty, nor is it seriously affected by wet weather if proper methods are employed in making the seed bed deep and loamy. By frequent and shallow cultivation the moisture is conserved for the use of the plants. This also makes the soil desirable for trucking purposes.

The type has only a limited acreage in the county, its occurrence being confined to isolated areas upon the lower foothills or level plateaus bordering the Choccolocco and Coldwater mountains. Its topography is gently rolling to hilly.

The Dekalb sandy loam is of the same origin as the Dekalb stony loam, being derived from the underlying Weisner sandstone formation. Owing to its position at the foot of the mountains some additional materials have been added by wash from the higher elevations.

For the first few years after this soil is cleared and put under cultivation the yields obtained are often equal to those obtained from the valley lands. The principal crops are cotton and corn, but without the addition of more humus to the soil the yields are soon reduced. This soil is not well suited to clover, but cowpeas make a vigorous growth, and it is urged that more attention be given to the growing of this crop. Its value in supplying nitrogen and humus to the soil is quite generally understood, but it is rarely practiced upon this soil. The Dekalb sandy loam is a warm, early soil. It is well suited to light trucking and fruit growing. It is better suited, however, to the growing of peaches than apples. Its use for watermelons, cantaloupes, cucumbers, sweet potatoes, etc., is recommended.

The value of this type of soil ranges from $10 to $20 or $30 an acre, according to the location.

The following table shows the results of mechanical analyses of this type:

Mechanical analyses of Dekalb sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
20183	Soil	1.6	13.2	9.7	23.0	16.5	24.5	11.2
20184	Subsoil	1.0	11.2	8.9	20.0	14.3	21.5	22.6

CONASAUGA CLAY.

The Conasauga clay, from 4 to 10 inches deep, with an average depth of 7 inches, is an ash-gray to brown heavy silt loam or clay loam, underlain by a silty clay or clay loam to 15 or 20 inches, below which it grades into a stiff, plastic clay. The color of the subsoil varies from light yellow to reddish, being mottled in the lower depths. The type is generally known as "flat woods" and is extensively

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developed in both Etowah and Cherokee counties, but is not very typical in Calhoun County.

This type occurs chiefly along the northern border of the county in the vicinity of the intersection of Etowah, Cherokee, and Calhoun counties. The areas are of limited extent and are similar to the Dekalb loam except for the higher percentage of silt and clay in the soil. A small area occurs about one-half mile west of the Cochran Springs school, in the northwestern part of the county.

The Conasauga clay is derived from the weathering of the underlying shales and siliceous limestone, as shown by the frequent occurrence of chert fragments upon the surface. The shales were observed in cuts at depths of 6 to 8 feet below the surface.

The topography is generally flat to slightly rolling, but owing to the stiff, impervious nature of the subsoil the drainage is usually inadequate and has to be supplemented with open ditches. It is subject to drought and in wet seasons it is difficult to handle. The best results are obtained from the use of the revolving-disk plow, but generally the one-horse breaking plow, which turns up from 2 to 3 inches of soil, is used. Deeper plowing and shallow cultivation should be practiced and more attention given to the growing of cowpeas, clover, grasses, oats, etc., to diversify the crops and increase the supply of humus in the soil.

The native timber growth consisted of oaks, hickory, sweet gum, dogwood, and pines. Most of the merchantable timber has been removed, but only a small percentage of the type is under cultivation. It produces from one-fourth to one-half bale of cotton per acre and from 10 to 15 bushels of corn per acre. The land is valued at $5 to $10 an acre.

HOLSTON FINE SANDY LOAM.

The soil of the Holston fine sandy loam to a depth of 8 to 12 inches, with an average depth of 10 inches, is a gray to brown fine sandy loam, containing a high percentage of very fine sand and silt. On the knolls the soil is shallower, in some instances being only 4 inches deep, and some exposures of a reddish-yellow fine sandy clay were observed. The subsoil is a yellow fine sandy clay, becoming slightly mottled with red at 30 inches in depth. Below 3 feet it is red, as shown by road cuts.

This is an easy soil to cultivate, being loose and friable and free from rocks or gravel. It occurs scattered over the western half of the county in bodies varying in size from small patches to areas of 1 to 3 square miles in extent. The largest continuous area extends from Cochran Springs schoolhouse, along Ottery Creek, to the Coosa River. The second largest body is found 1½ miles west of Boiling Spring Church, extending north from Cane Creek along the Coosa River to within a mile of Ohatchee Creek. Smaller areas occur near

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Francis Mill and about 1 mile west of Sulphur Springs Church and 1 mile east of Fombys Ferry. Other small patches are scattered over the western half of the county.

The topographic features of the Holston fine sandy loam are level to gently rolling. The area occurring in the vicinity of Cochran Springs schoolhouse is more rolling than that occurring north of Cane Creek. The gently rolling surface of the Holston fine sandy loam affords ample drainage, and in some cases it is excessive, causing the soil to become droughty.

The Holston fine sandy loam seems to be of both alluvial and residual origin, the soil being more or less alluvial and the subsoil apparently residual, being derived in part from the underlying shales and sandstones.

The native timber growth upon this type is oak, persimmon, hickory, and longleaf pine. From the latter growth it derived the name "sandy piny-woods land."

The principal crops at present grown upon the Holston fine sandy loam are cotton and corn. With favorable seasons cotton yields from one-fourth to one-third bale per acre and corn from 10 to 12 bushels per acre. Wheat and oats are grown in small patches, yielding from 10 to 12 bushels per acre. Sorghum does not yield as many gallons as on some of the other types, but the color of the sirup is much lighter and it sells for a higher price.

This type is well adapted to trucking. Besides being loose, loamy, and well drained, it is a warm soil, which permits the crops to make an early start and quick growth when properly fertilized and cultivated. Watermelons, cantaloupes, tomatoes, sweet and Irish potatoes, turnips, and nearly all vegetables produce good yields. Fruits on the Holston fine sandy loam give good results when properly sprayed and pruned, apples, plums, apricots, Scuppernong grapes, blackberries, raspberries, and strawberries all doing well. Peaches are often damaged by late frosts. The lack of transportation facilities to markets hinders, at present, the full development of the trucking industry and the possibilities of the soil. Cowpeas make good returns of hay and are a valuable source of adding humus to the soil, in which it is lacking. Red clover produces fairly good yields. Besides furnishing excellent pasture, it is also valuable as a green manure to be turned back into the soil. Crab, orchard, and Bermuda grasses grow well, and when cut for hay produce from 1½ to 2 tons per acre, and, in addition, furnish excellent pasture.

Deep plowing is very beneficial to this type and should be more generally practiced, as it enables the soil to withstand drought much better. The turning under of green manures by adding humus to the soil is very helpful. The raising of more live stock and in turn putting the manure on the fields would be profitable.

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The houses are usually two or three room frame buildings. The outhouses, barns, etc., are usually built of logs. The fences are only in fair condition, owing to the fact that material for their construction is scarce. The soil type is valued at from $8 to $15 an acre.

The following table gives the results of mechanical analyses of samples of soil and subsoil of this type:

Mechanical analyses of Holston fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
20147	Soil	0.5	6.4	8.3	23.4	18.1	34.2	8.4
20148	Subsoil	.2	4.0	5.9	18.6	17.8	31.2	21.8

HOLSTON GRAVELLY SANDY LOAM.

The finer soil of the Holston gravelly sandy loam to 8 inches in depth is a brown medium to fine sandy loam, and from 8 to 12 inches a gray fine sandy loam. The surface is strewn with fine and coarse rounded quartz, sandstone, and chert gravel, including some angular fragments. A few small patches were found where the finer material had an ashy feel, this property being imparted to the soil by the relatively large amount of silt which it contains. The subsoil is a yellow fine sandy clay or yellow clay loam containing much coarse material and small, sharp fragments which impart a gritty feel. In the lower depths the subsoil becomes mottled red and yellow, and sometimes it is yellowish red.

The Holston gravelly sandy loam is usually easy to cultivate. Although the rounded gravel may entirely cover the surface, it does not interfere with cultivation.

The largest continuous body of this type extends from Ohatchee, bordering on Ohatchee Creek, to the Coosa River. The second largest area extends from Fombys Ferry along Acker Creek and the Coosa River to within a short distance of Cane Creek. The third largest body occurs about 1 mile west of Anniston. Smaller areas occur in other parts of the western half of the county.

The topographic features of the Holston gravelly sandy loam are similar to those of the Dekalb shale loam, in that the hills or knobs are rounded, which causes the water to run off very rapidly. The knolls of the Holston gravelly sandy loam are, however, more flattened on top and the slopes steeper. In most cases the drainage is excessive, so that in general the soil is inclined to be droughty, but it is not as subject to drought as the Holston fine sandy loam or Dekalb shale loam.

The Holston gravelly sandy loam is not wholly of residual origin, as it seems from the rounded quartz gravel that it was transported by

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water. The subsoil may be residual, being derived from a siliceous member of the limestone or dolomite formation, or partially from shales, and reworked to some extent, as the gritty material found in it is often rounded and appears to be riverwash.

The native vegetation was longleaf pine, and in the more gravelly spots black-jack oak grows in abundance. Farming is not pursued to a very large extent on this type, as only about one-third of it is under cultivation. Cotton and corn are the principal crops, and in favorable seasons cotton produces from one-fourth to one-third bale per acre and corn from 10 to 15 bushels per acre. Small fruits do well on this soil. Apples give good yields, as do plums and grapes, but peaches do not yield as well.

The planting of cowpeas is very beneficial. They not only yield very good crops of hay, but add humus to the soil, in which this type is deficient. Deep plowing is also advisable, as it enables the soil to withstand drought better.

The farmhouses and outbuildings on this soil type are usually built of logs, the houses generally containing from two to three rooms. There are a few frame houses, however, which are built of undressed lumber. Land of this type sells for $10 to $15 an acre.

The following table gives the results of mechanical analyses of soil and subsoil of the Holston gravelly sandy loam:

Mechanical analyses of Holston gravelly sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
20149	Soil	2.1	11.1	8.1	15.2	10.9	36.6	15.7
20150	Subsoil	2.9	8.7	5.2	9.1	4.7	36.9	32.4

HUNTINGTON SILT LOAM.

The Huntington silt loam is the most extensive bottom-land type in the area. Its surface soil from 6 to 10 or 12 inches in depth, averaging about 8 inches, is a gray to brown silt loam. The texture is fairly uniform over large areas, but where it occurs in narrow bottoms along the smaller streams the soil is largely made up of materials which have been washed in from the adjacent uplands and is always more variable in color and texture. The slightly depressed or poorer drained areas which occur throughout the type have a darker colored soil, because of the accumulation of more organic matter. In the eastern portion of the county, where the soil occurs along with the Talladega slate loam and receives the washings from the hills of the latter, it is of a uniformly fine silty texture, containing but a very small percentage of coarse material.

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Where it occurs along with the Clarksville stony and gravelly sandy loam, in the central and western parts of the county, chert fragments are frequently encountered in the soil profile.

The subsoil of the Huntington silt loam is a yellow to yellowish-brown heavy loam or compact silt loam about 15 or 18 inches deep, which grades into a silty to fine sandy friable clay or clay loam. In the depressed, poorly drained areas it is more often of a dark-gray color and more plastic. In a few localities the subsoil is a stiff, tenacious, bluish-gray clay, and the presence of iron stains in the lower depths gives it a mottled appearance.

When this type is adequately drained it is generally considered an easy soil to cultivate, but if plowed when wet it clods and bakes. Better results are obtained when the soil is plowed in the fall, but if it is covered with water for any considerable period during prolonged wet seasons it runs together and must be replowed in the spring.

The Huntington silt loam is most extensively and typically developed in the present flood plains of Choccolocco Creek, in the southeastern portion of the county. It occurs, however, as the main type of first bottom lands along the creeks and branches in almost every section of the county, varying from a few rods to 1 mile or more in width.

The topography is comparatively level, so that frequently the drainage is inadequate. In some instances open ditches have been constructed to drain depressions and semiswampy areas, but almost no attention has been given to a systematic drainage of this soil. The yields on this type could be greatly increased if more attention were given to thorough drainage.

The Huntington silt loam is composed of an intermixture of sand, silt, and clay, representing colluvial materials which have been washed in from adjacent uplands or depositions of finer alluvial materials which have been carried long distances during floods. The coarser materials usually occur deposited in the sharper bends adjacent to streams where the current is swift. These areas were mapped separately and correlated with the Huntington fine sandy loam when they occurred in sufficiently large bodies.

This type is used mostly for the production of corn, to which it is probably best adapted, and yields of 30 to 50 or 60 bushels per acre are obtained. When properly drained this soil produces large yields of wheat and oats. As high as 100 bushels of oats per acre have been obtained, and 40 to 60 bushels can be made without the use of fertilizers. Wheat is not grown to any extent at the present time, but where the fields are not subject to overflow it should be included in a definite crop rotation, to which not enough attention is given. In many instances it is cropped exclusively to corn. Cowpeas should always be sown in the corn when this system is followed.

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The better-drained areas of Huntington silt loam have been used to some extent for growing apples, one large orchard in the southeastern portion of the county upon this type yielding profitable results. The apples were mostly made into cider and vinegar.

This type is also well suited to grasses and makes good pasture land. Yields of from 1 to 2½ tons per acre of Johnson grass are obtained. Cotton is frequently damaged by overflow and is not well suited to this soil. Deep tillage, better drainage, and a more systematic crop rotation are essential to obtain the largest yields from this type.

Very little of the Huntington silt loam is listed for sale. It is held at $20 to $100 an acre, depending on location and improvements.

The following table gives the results of mechanical analyses of samples of the Huntington silt loam:

Mechanical analyses of Huntington silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
20185	Soil	0.0	1.0	1.6	6.3	7.9	62.0	21.2
20186	Subsoil	.0	.7	3.4	10.4	6.5	45.0	34.0

HUNTINGTON FINE SANDY LOAM.

The surface soil of the Huntington fine sandy loam, from 5 to 8 or 10 inches deep, with an average depth of 7 inches, is a brown to light-brown or yellowish fine sandy loam. The subsoil is a yellow to yellowish-gray heavy loam, grading into a light-yellow to reddish-yellow silty to fine sandy clay. This is also a bottom-land type, but it is not so extensively developed in the county as the Huntington silt loam. Where it occurs along the Coosa River the subsoil is lighter or more sandy in texture and of a yellowish-red to brown color. Approaching the river banks the soil to a depth of 3 or more feet frequently has a fine sandy loam texture. Noticeable quantities of mica were also observed in both the soil and subsoil.

The surface of the Huntington fine sandy loam is practically level, with sufficient slope to give adequate drainage, and the looser structure of both soil and subsoil also contributes to its better drainage conditions. It is subject to overflow, but it is only at times of very high water that crops are damaged. It is a better drained soil than the Huntington silt loam and is easy to cultivate. This type is widely distributed over the county, being found chiefly along Ohatchee, Tallahatchee, Cane, and Choccolocco creeks and their tributaries and along the Coosa River. It is formed principally by the deposi-

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tion at times of overflow of the finer grades of sand by the swift flood waters of the streams along which it occurs. Some materials have also been added as wash from the adjacent uplands.

The native vegetation consisted of post-oak, shortleaf and longleaf pine, persimmon, water oak, and occasionally gum. Most of the type has been cleared and is under cultivation. It is well adapted to trucking, especially cabbage, beets, radishes, onions, and Irish potatoes. It is also well suited to small fruits, apples, plums, pears, etc. Peaches, however, do not do so well as the other fruits. While the yields are sometimes satisfactory, the quality is never equal to those grown upon the hills and mountains. Cotton yields somewhat better than on the silt loam, but it is frequently subject to rust. Corn is the main crop grown, with yields varying from 35 to 50 bushels per acre. Oats are particularly well suited to this soil, yielding 50 to 75 bushels per acre. Grasses also do well and yields of 1 to 2 or 3 tons per acre of crab grass and Johnson grass are obtained. Millet also produces well.

To obtain large yields of hay from highly fertilized flats of this type the following is suggested: Sow the soil to wheat in the fall and cut for hay in the spring. Turn the stubble under with a two-horse breaking plow, 8 inches deep, and sow millet, cut and again reseed to millet. By this method about 7 tons per acre have been obtained. It affords the best pasture land of any soil in the area and is used quite extensively for this purpose.

The Huntington fine sandy loam, like the silt loam, is a very highly prized soil and is not generally listed for sale, but when sold the prices range from $20 to $50 or $100 an acre. When it occurs in the vicinity of larger towns it is valued quite highly, but its use for trucking purposes has not been generally recognized.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of the Huntington fine sandy loam:

Mechanical analyses of Huntington fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
20189	Soil	0.0	1.7	9.1	32.7	14.7	33.2	8.7
20190	Subsoil	6.1	8.3	2.5	7.8	8.1	46.8	20.3

TALLADEGA SLATE LOAM.

The soil of the Talladega slate loam, from 4 to 10 inches deep, with an average depth of 5 or 6 inches, is a grayish to brownish silty loam, or loam containing a rather high content of lustrous shale frag-

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ments. The subsoil is a yellowish to reddish silty clay or clay loam, having a greasy feel. The underlying shales are frequently encountered at depths ranging from 12 to 20 inches. These consist of greenish, bluish, purplish, pearly, or lustrous shales, with interstratified layers or lenses of quartz, and quartzite conglomerate, fragments of which frequently occur upon the surface and throughout the soil profile. Fragments of shale and slaty material are also found similarly distributed over the surface and throughout the soil and subsoil. These have a greasy feel, which is also noticeable in the finer materials of the surface soil. On the lower slopes, where erosion has been especially active, the shale fragments constitute most of the soil mass. In some instances the soil covering is shallow and quite variable in texture.

This type occurs as an unbroken irregular strip from 1 to 3 or more miles wide along the eastern and southern boundaries of the county. A few small isolated areas were also mapped in the vicinity of Choccolocco. The drainage is usually rapid or excessive, and owing to the loose, incoherent character of the materials composing the soil it is easily eroded, so that terracing is necessary to prevent washing before the land can be safely cultivated. Even these do not prevent the washing away of the soil, and frequently the fields become so badly eroded and leached as to cause them to be abandoned after a few years.

The topography is very broken, consisting of sharp and toothed ridges or knobs and narrow precipitous valleys, with elevations ranging from 1,000 to 1,200 or more feet above sea level, or 500 to 700 feet above the general level of Choccolocco Valley. It includes portions of Horseblock, Bynum, and Rattlesnake Mountain ranges, belonging to the metamorphic belt. The valleys are narrow and crooked, varying from 300 to 400 feet in depth, and are used mostly for corn and sorghum. Some of the wider valleys are used for hay and pasture, but as a rule little forage is grown.

The Talladega slate loam is formed by the disintegration or weathering of the underlying hydromica or imperfectly crystalline slates, which have a variable composition. Some materials being more easily weathered than others go to form the finer earth material, while the more resistant parts are left as fragments upon the surface and throughout the soil profile. The latter more often represents the quartz and quartzite occurring as veins or lenses throughout the slaty formation.

Owing to the rough, broken character of the country and the tendency to erode when cleared, very little of this type is under cultivation. Most of it is in native timber growth, consisting of oak, hickory, longleaf and shortleaf pine, bay, ash, and mountain laurel. The mountains are, however, rapidly being depleted of their mar-

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ketable timber, and a large percentage of the timber now standing is second growth. This forest covering should be allowed to stand, especially where the land is held in large tracts, as is frequently the case. It affords fairly good range for cattle, sheep, goats, and hogs, for which it is generally used. Sheep raising is frequently rendered unprofitable by the ravages of dogs and wild animals. If steps were taken to protect the sheep a profitable industry could be built up, and land which is of little value for general agriculture could be made to yield good returns. When the soil is cleared and cultivated on the uplands it should never be left without a cover crop of some kind in winter to prevent washing. Oats, rye with vetch, and grasses would serve this purpose and at the same time make excellent forage. It is fairly well adapted to wheat and corn, but these are grown mostly in the valleys. Stock raising would probably yield the best returns, aside from the timber and mineral resources.

The Talladega slate loam is usually held in large tracts by mineral companies and at prices ranging from $2 to $5 or more an acre.

The results of mechanical analyses of samples of the soil and subsoil are shown by the following table:

Mechanical analyses of Talladega slate loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
20197	Soil	0.0	2.0	10.0	28.7	13.0	31.7	14.6
20198	Subsoil	4.3	8.4	3.0	9.3	9.5	41.1	24.0

SUMMARY.

Calhoun County is located in the northeastern part of Alabama. It lies almost entirely within the Coosa Valley and contains a total area of 397,440 acres, or 621 square miles. The topography is generally rolling to hilly or mountainous, with elevations ranging from about 600 feet in the valleys to more than 2,000 feet above sea level upon the mountains. All the drainage waters of the county find an outlet through the Coosa and Alabama rivers to the Gulf of Mexico.

The transportation facilities include four railroads and the Coosa River, which is navigable from Lock No. 4, in Talladega County, to Rome, Ga.

The climate is mild and equable. The mean annual temperature ranges from 44° F. in winter to 77° F. in summer. The average dates of the first and last killing frosts are October 20 and April 2. The mean annual precipitation is slightly less than 50 inches and is evenly distributed throughout the growing season.

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The climate is adapted to a wide range of diversified agriculture and is especially well suited to stock raising on account of the mild winters, which makes it possible to pasture stock practically the year round. The water supply is obtained from springs and wells.

Cotton and corn are the staple crops. The growing of cowpeas, peanuts, clover, and other legumes has done much to build up the lands, but this practice is limited to a few of the more progressive farmers, who operate their own farms. Their use should be extended. Forestry, together with stock grazing, including cattle, sheep, and goats, should be more generally practiced on the rougher mountainous lands; also more fruit and truck should be grown.

The land values in the county have slightly advanced in the last few years and range from $2.50 an acre on the hill lands to from $10 to $40 an acre in the valleys, while some of the improved bottom lands bring as high as $60 to $100 an acre.

The soils of the county are derived directly or indirectly from limestone, sandstone, and shale. Eighteen distinct types are shown in the accompanying soil map.

The Dekalb stony loam occupies the foothills of the mountains, and is derived largely from the weathering of the underlying sandstones. It is mostly in forest growth, but when put under cultivation fair yields of corn and cotton have been obtained. It is well suited to peaches and light trucking and is valued at $5 to $20 an acre.

The Montevallo shale loam is derived from the weathering of sandstones and variegated shales of the Montevallo geological formation. Its topography is hilly to mountainous. The type is largely in native timber, but these areas under cultivation yield from 10 to 25 bushels of corn and from one-fourth to one-half bale of cotton per acre. It is held at $10 to $20 an acre and is valued chiefly for its timber, mineral resources, and its use for pasture.

The Decatur stony loam is a rolling to hilly soil, with good drainage. It yields one-half to three-fourths bale of cotton, 10 to 20 bushels of corn, and 20 to 40 bushels of oats per acre, and is well adapted to fruit. Its valuation is from $8 to $20 an acre.

The Decatur loam is of limestone origin and occupies moderately rolling valley lands with excellent drainage. It is well suited to corn, cotton, oats, clover, cowpeas, fruits, and vegetables, and is valued at $12 to $20 an acre.

The Decatur clay loam is one of the strongest soils in the area and is derived from the underlying limestones. The topography is usually flat to gently undulating and the soil is well suited to the use of labor-saving machinery. Being one of the heavier types, it is difficult to handle, but when properly managed it yields one-half to 1 bale of cotton per acre and 30 to 50 bushels of corn per acre. It is practically all under cultivation, and is valued at $15 to $50 an acre.

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The Holston gravelly sandy loam is partly of alluvial and partly of residual origin. Cotton and corn are the principal crops, the former yielding from one-fourth to one-third bale per acre and the latter 10 to 15 bushels per acre.

The Holston fine sandy loam has a gently rolling surface and is well drained. Cotton and corn are the chief crops. It is also adapted to hay and early truck. This type is valued at $5 to $50 an acre, depending on location.

The Dekalb loam, Dekalb shale loam, and Conasauga clay are derived from shale. They are easily eroded and are difficult to handle, but when first cleared and put under cultivation fair yields of cotton and corn are produced. They are well suited to cowpeas, Johnson, orchard, and Bermuda grass and should be used more for these crops. It is usually necessary to construct terraces to prevent washing. This could be prevented largely by the growing of winter cover crops. They are valued at $5 to $10 an acre.

The Clarksville stony loam, gravelly sandy loam, and loam are all derived from the weathering of the more siliceous or cherty limestones. The stony loam type is usually more rugged and less suited to general farming purposes than the other members of the series. It is well adapted to peaches. The gravelly sandy loam and loam are adapted to apples, plums, pears, and small fruits. They are also well suited to hay and pasture and are valued at $2.50 to $10 an acre.

The Huntington fine sandy loam and the Huntington silt loam are of alluvial origin and are formed from materials transported long distances or washed in from the surrounding upland. They are well adapted to corn, hay, wheat, oats, and pasture, but are rarely used for cotton, except the better drained areas of the Huntington fine sandy loam, which is also well suited to truck. These soils comprise some of the most highly prized soils in the county and are valued at $20 to $100 an acre.

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SOIL SURVEY OF BIBB COUNTY, ALABAMA.

By W. E. THARP, of the U. S. Department of Agriculture, and W. L. LETT, of the Alabama Department of Agriculture and Industries.

DESCRIPTION OF THE AREA.

Bibb County is situated slightly west of the geographical center of the State of Alabama. It is roughly triangular in shape, the southern boundary, which is about 25 miles in length, forming the base. From this line to the extreme northern end is a distance of about 28 miles.

The county is bounded on the northwest by Tuscaloosa County, on the west by Hale County, and on the south by Perry and Chilton, the latter also forming most of the eastern boundary. Jefferson and Shelby counties lie to the north and northeast, respectively. The area of the county is 403,200 acres, or about 630 square miles. The average elevation is about 500 feet.

The parallel 33° north latitude passes a little north of the middle of the county, and meridian 87° west longitude intersects this line near Six Mile.

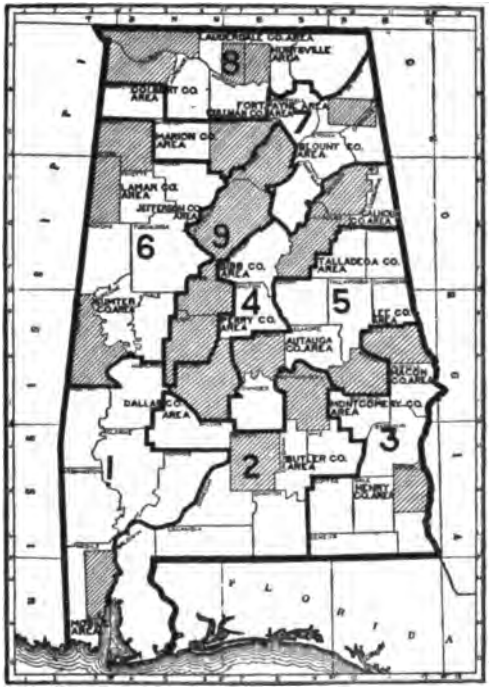

FIG. 16.—Sketch map showing the location of the Bibb County area, Alabama.

The surface of most of the county is hilly, and in places decidedly broken. The whole area may be considered an elevated plain deeply trenched by a drainage system cut to an extreme depth of 200 feet or more below the original surface. The hills thus left in relief vary in character with the nature of the material composing them. In the northeastern townships the ridges of Coal Measure sandstones present some very broken areas along the streams, but in general their slopes have rather moderate gradients. Along the southeastern

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border of the Coal Measure sandstones there are outcrops of the Trenton limestone and the associated highly siliceous rocks, evidently representatives of the Knox dolomite. They have a general northeast-southwest strike, giving rise to some very broken areas along the Cahaba and Little Cahaba rivers.

The remainder of the county presents quite a variety of topographic forms. While the uplands between the larger creeks are hilly, a considerable portion of their surface is available for agricultural purposes. Undulating to gently rolling areas varying from a few hundred to a thousand or more acres may be found on most of the interstream divides. The roughest parts of the upland areas are the gravel and ironstone capped ridges. This stony covering protects the unconsolidated sands and clays with the result that narrow, steep-sided divides have been formed. This kind of topography is found east and southeast of Centerville, particularly between the south county line and the Cahaba River.

In the extreme western part of the county similar features prevail, but the relief is greater, at least more sharply accentuated. The rocky surface material consists chiefly of broken, iron-cemented sandstones with comparatively little crystalline gravel. A view from any commanding point shows a succession of pine-clad hills varying considerably in height. From the central divides shorter trenches and spurs separated by deep ravinelike valleys slope toward the main drainage lines. These secondary ridges are frequently broken into steep-sided conical hills. Where the latter are superimposed upon a divide or of unusual size, they rise in clear relief above the general level.

Nearly all the county is drained by the Cahaba River. A limited area in the western part is tributary to the Warrior River, and a few square miles of the eastern portion drain into Mulberry Creek, a branch of the Alabama River.

The Cahaba River enters the northeastern part of the county and after following a southeast course crosses the south county line near its middle point. Below Centerville it is rated as a navigable stream.

From the north part of the area the river receives Caffee and Shade creeks. Schultz Creek, which drains much of the northwestern townships, joins the main stream about 4 miles north of Centerville. Most of the western and southwestern parts of the county are drained by Haysoppy, Affonee, and Blue Guttee creeks. Each has a southeasterly course and empties into the Cahaba River, the last-named stream joining it in Perry County.

The largest eastern tributary is the Little Cahaba River. It is a crooked stream flowing westward through some very broken country. It receives considerable drainage from the south. Six Mile Creek, its largest tributary wholly within the area, receives the waters from

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approximately 50 square miles of country which has a general surface inclination toward the north. A broad divide extending from Randolph westward to "Soap Hill" separates this north-flowing drainage from that which goes west or south. The latter forms the head waters of Oakmulgee Creek and the former makes the numerous branches of Sandy Creek. Each of these streams usually maintains its flow throughout the entire year.

The Cahaba River has practically no bottom land above Centerville. None of its tributaries entering above this point has more than occasional strips of alluvium. Below Centerville the Cahaba has a true flood plain which widens toward the south. Bounding this low plain on the west is a second bottom with a maximum width of about 2 miles. Opposite Centerville there is a high terrace intermediate in elevation between the second bottom and the hills to the west. Its undulating surface affords several square miles of excellent farming land. Remnants of this terrace are observable below Harrisburg. On the west side of Copperas Creek, a north-flowing tributary of Six Mile, a similar high terrace is found. All the larger creeks in the south half of the county have more or less alluvium. Much of it requires artificial drainage to render it fit for farming.

The majority of the early settlers came from the Carolinas. Georgia and Tennessee contributed a considerable number, with additions from the northern and eastern parts of the State. The valley of the Cahaba was soon occupied, but as its lands were held, for the most part, in large tracts the population was never numerous. Some of the best bottom lands on the creeks were cleared at an early date. A few of the first settlers located in the hills, but most of the rougher sections were practically uninhabited until after the war.

The coal mines between Blocton and the Cahaba River have been opened within the last twenty-five years. Several thousand people now live in this section, but very few of them are farmers. Belle Ellen, Piper, Hargrove, and Lucille are small mining towns.

Centerville and Blocton are the largest towns. The former is the county seat and the latter is the business center of the mining interests. The other towns of the area are small villages. Those located on the Mobile and Ohio Railroad and the Southern Railway are good shipping points. The last-named line touches the eastern townships. The Mobile and Ohio Railroad crosses the county diagonally and affords good shipping facilities to Montgomery and also to St. Louis and intermediate points. The "Mineral Division" of the Louisville and Nashville Railroad places Blocton in easy communication with Birmingham.

The public roads between the towns are being rapidly improved. Rural telephone lines are numerous, and the free delivery of mails extends to all the better-settled sections.

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CLIMATE.

This section of the State is favored with a climate that admits of the profitable cultivation of a great variety of crops. Most of the staple productions of the northern States may be grown, and many tender fruits and vegetables of the south have time to mature between the dates of killing frosts. Field work can be carried on the entire year, with the exception of a few weeks in midwinter.

The annual rainfall of about 50 inches is fairly well distributed. While the yields of corn and cotton are sometimes reduced by unfavorable weather, it is exceptional for crops on well-prepared land to be seriously affected by drought.

The range of temperature for each season falls within comparatively narrow limits, giving a climate that is mild and uniform. There are occasional light falls of snow; the ground now and then freezes to a depth of several inches.

No Weather Bureau station is maintained in this county. The following table has been compiled from the records of the nearest station, Greensboro, which is about 35 miles southwest of Centerville:

Normal monthly and annual temperature and precipitation, etc., for Greensboro.

Month.	Temperature.			Precipitation.			
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year.	Total amount for the wettest year.	Snow, average depth.
	° F.	° F.	° F.	In.	In.	In.	In.
January	45	78	12	5.2	5.4	4.4	0.2
February	50	79	− 5	4.7	2.0	4.4	1.3
March	55	85	21	5.2	1.5	11.2	.0
April	64	90	31	4.2	6.6	2.2	.0
May	72	95	42	3.7	.6	2.4	.0
June	78	100	50	4.0	3.4	4.1	.0
July	80	105	60	3.6	4.5	3.4	.0
August	79	100	59	4.4	3.0	9.3	.0
September	75	96	45	2.8	1.9	7.9	.0
October	64	92	33	2.1	.4	4.4	.0
November	55	84	21	3.8	4.1	3.1	Trace.
December	49	75	10	4.8	2.2	2.2	.3
Year	64	105	− 5	48.5	35.6	59.0	1.8

Average date of last killing frost in spring, March 20, and of the first in fall, November 8. Date of latest killing frost in spring, April 5, and of the earliest in the fall, October 24.

AGRICULTURE.

The settlement of this area began very early in the last century. There was a village at the falls of the Cahaba, opposite the present site of Centerville, about 1810, and a few years later it appears in

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the court records as the county seat of Cahaba County. In 1818 the name Centerville was adopted and in 1821 the county was named Bibb. There were at this time probably several hundred settlers, most of whom were located on the second bottom of the Cahaba River and the larger creeks.

About 1821 the survey of the public lands in this part of the State was completed. In accordance with the law at that time governing their disposal they were sold at auction. Most of the settlers for a few dollars per acre secured sections or fractions thereof on which they had made improvements. In the following years a comparatively few wealthy men acquired large holdings of land located, for the most part, in the valleys. The high timbered ridges were considered nearly worthless, and portions of the least accessible land remained unclaimed until the timber and mineral values were recognized.

By 1830 several of the present estates in the Cahaba Valley and some large farms in other parts of the county were fairly well improved and were producing large crops of corn and cotton. Cattle were raised in comparatively large numbers, but stock growing as a business does not seem to have ever ranked in importance with the production of the crops mentioned.

At that time the county offered excellent grazing. The uplands were covered with a rather open forest of longleaf pine, probably as fine as any in the South. The undergrowth included more herbaceous plants and less scrub oak and small trees than at present. Much of the bottom lands along the creeks and nearly all the ravines were not then timbered, but supported a dense growth of cane. There was little necessity of producing winter feed for any stock, except the horses and mules used on the farms. The cane has almost entirely disappeared, and pasturage upon the uplands is now in most places of inferior value. It may be added that the habit of depending upon the open range for support of the cattle still obtains with the farming class, and accounts in a large measure for the indisposition to take up the culture of forage crops.

For many years Mobile was the only market for cotton. Boats were built on the Cahaba River, loaded with cotton, and floated to the Gulf port. These were frequently poled back loaded with such supplies as were needed in the country stores. Later Selma became an important trading point and continued so for many years.

The general trend of agriculture in this county since 1850 is fairly well indicated in the following table compiled from the United States census reports. It gives the total production of each of the four principal crops for the year preceding that in which the census was taken.

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Yield of staple crops of Bibb County, Ala., 1850 to 1900.

Year.	Cotton.	Corn.	Wheat.	Oats.
	Bales.	*Bushels.*	*Bushels.*	*Bushels.*
1850	4,634	343,455	219	19,676
1860	8,308	411,130	15,393	7,143
1870	3,973	82,620	6,826	13,645
1880	4,843	236,086	16,700	21,926
1890	5,216	254,277	158	33,891
1900	6,585	310,200	2,112	51,600

Since the depression immediately following the war the production of cotton has steadily increased. There has also been an increase in the acreage as well as the production of corn. The given production of oats is an estimate only, for very little of this grain is ever thrashed. At present no wheat is grown.

The present type of agriculture is in the main similar to that which developed in the fifteen or twenty years following the war. There was then practically no accessible market for anything except cotton. A local demand for corn, pork, and a few other supplies existed, but few farmers produced more than enough for their own use. The negro laborers, whether working for wages or as tenants, were not generally successful with any crop except cotton. These conditions and the high price of the staple in the early seventies stimulated its production and it has since continued to dominate the agriculture of the county.

In recent years the production of fruits and vegetables, and the acreage devoted to cowpeas, sugar cane, and other minor crops, has probably increased, but the total production is comparatively small. With the exception of some truck growing near Blocton this branch of business receives very little attention. The local demand for poultry and dairy products is not well supplied. Corn, oats, hay, and other feedstuffs command good prices, and in recent years it has been necessary to import more or less of such products.

The present markets, the variety of soils, and the climate are highly favorable to a more diversified type of agriculture than now prevails. Suitable soils for the production of small fruits and various kinds of truck crops may be found. On the lighter soils there is a good opportunity for the cheap production of meats by growing forage crops with peas and peanuts as a substitute for grain. Stock growing does not receive the attention it deserves. Nearly all the horses and mules used are imported from other States. There seems to be no reason why a light type of horse suitable for driving and for farming on hilly lands could not be raised in this section.

In general, the present cultural methods do not favor the preservation of moisture in the soil, which is often of vital importance later

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in the season. In nearly all types fields may be found which have a distinctly hard stratum a few inches below the surface, the result of continuous shallow plowing. Heavy soils should be broken deep in order to have enough loosened earth to work down to a good seed bed. The physical condition of the fine sandy loams would be improved by mixing more of the clay of the subsoil with the sand of the surface, provided that the increase in depth of plowing were gradual and the after-cultivation more thorough. Such methods of tillage would require heavier implements than are now in general use.

All of the soils are deficient in humus. The climatic conditions and the cultural practices hasten the exhaustion of the original supply in the virgin lands. The production and preservation of this highly essential element should be one of the first objects in soil management. On all farms the supply of barnyard manure is so meager that the fertility of the land can not be greatly increased by its use alone. The cheapest way to obtain anything like an adequate increase in the amount of vegetable matter is to grow it on the land. The legumes are most valuable, but oats and rye may often be sown as catch crops without special preparation of the land, and turned under for the benefit of the subsequent crop.

The following rotation, recommended by the State experiment station, could be easily adopted on the majority of farms. First year, corn, with cowpeas, either broadcast or drilled between the rows; second year, oats (fall sown), followed by cowpeas or soy beans; third year, cotton, with crimson clover sown between rows in fall, or in place of oats or rye.

Such a cropping system has much to commend it. If the secondary crops are pastured or even cut for hay much vegetable material remains on the land. It insures the presence of nitrates, and also furnishes a soil cover during the winter months. The last is highly essential on all the upland fine sandy loams and would be of material benefit to the heavier soils.

It should also be borne in mind that in a soil well stocked with humus the nitrogen supply is not only increased, but the presence of organic acids assists in rendering available the potash and phosphates already in the soil or which may be added as a fertilizer. In the rotation here given no nitrates need be purchased and the requirements of any crop with regard to potash could be supplied by purchasing muriate of potash, or kainit. The phosphoric acid could be obtained in the form of treated rock phosphate. These fertilizers, purchased separately, may be mixed with compost and applied in the usual amounts more economically than by the present method of buying low-grade goods. Many farmers make a practice of selling their cotton seed; others use it as a fertilizer. Unless the price is

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exceptionally high the latter is probably the better practice on most of the farms in their present condition.

According to the census of 1900 the value of farm lands exclusive of buildings is $975,775. This does not represent the present valuation, for in the last few years there has been a marked advance in the price of all lands, especially those adapted to the culture of corn and cotton. Well-located farms range in price from $25 to $50 an acre. Small farms in the hilly sections of the county bring $10 and $20 an acre. In general, the buildings on the latter are rather poor. One-story unpainted houses and small barns are commonly seen. Some farms are well improved, and there is a general tendency on the part of those who occupy their own land toward the construction of better buildings than were formerly erected. The old rail fences are being displaced by those of woven wire, especially in those "beats" where stock is not permitted to run at large.

The large estates are operated chiefly by tenants. In a few cases the entire plantation is leased to one man, who relets the tillable land to negro tenants on the customary terms, that is, for one-half the cotton produced. In most cases the tenant is furnished a mule, implements, seed, and one-half the fertilizer used.

Those farmers who have from 50 to 200 or 300 acres of tillable land usually rent a part of their farms and also employ one or more hands by the month to work the remainder. The wages given range from $10 to $15 a month. House rent is always included, and in some instances a stipulated quantity of supplies, or "rations," is also given.

On the large estates no radical changes from the present methods of management, nor even in the system of cropping, can be easily made. The negroes are not inclined to raise any crop except cotton, nor to use improved machinery, preferring the one-mule plow and cultivator. The annual rent received from these large holdings, while small considering their total acreage, constitutes a good rate of interest on the actual cost to present owners.

Many of the proprietors of the medium-sized farms desire to decrease their usual acreage of cotton or abandon its culture altogether. The higher price of labor and the increased cost of all supplies needed in its production renders the returns from cotton somewhat uncertain. The most practicable change for this class of farmers to make seems to lie in the cultivation of more forage crops and the keeping of more cattle and hogs. The latest labor-saving machinery should be used—implements adapted to the tillage of the particular structure of the soil on the farm. In some instances the cultivation of special crops, the kind depending upon location and soil type, could be safely tried. Methods of farm management based on the rotation of crops and taking into consideration the adapta-

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bility of the soil and the requirements of accessible markets may be made remunerative and at the same time result in the permanent upbuilding of the land.

SOILS.

Bibb County lies on the boundary between the extreme southern end of the Appalachian Plateau and the Coastal Plain. The line of contact between the rocks of the former region and the sedimentary materials which constitute the surface of the latter passes a little east of Greenpond, and southward through Blocton to the confluence of the Cahaba and the Little Cahaba rivers. From this point it follows an irregular course eastward, leaving the area near Brierfield. There are exposures of rock south of this line, particularly along the Cahaba River above Centerville, and a few patches of Coastal Plain deposits to the north. In general the boundary is fairly well defined by the difference in the character of the surface materials. To the north and east of this line the soils are residual. Each type represents the disintegration and decomposition of the underlying rock. To the south and west the upland soils are derived from either the Tuscaloosa or the Lafayette formation. The types found in this part of the county are more varied in composition and structure and their relation to each other and to the parent materials is not so simple as in the case of the residual soils.

The strictly alluvial soils of the Cahaba Valley are largely derived from sources to the north of the area. There is a marked difference, mineralogically, between the river alluvium and that of the tributary creeks. The latter consists almost entirely of reworked material from the Tuscaloosa and Lafayette deposits.

The oldest rocks which have to any degree affected an upland type are the Montevallo shales—a Cambrian formation that has limited exposures from a few miles northeast of Centerville to Shoals Creek. The Coal Measure sandstones form practically all the surface of the northeastern part of the county. They have given rise to the Dekalb fine sandy loam. Along the south and southeast borders of the Coal Measures the Trenton limestone has extensive outcrops. This rock has determined to a large extent the character of the land throughout a belt 2 or 3 miles wide, extending from the head of the Cahaba Valley to the northeast part of the county. Some of it is too broken to be of much agricultural value, but wherever the topography has permitted the accumulation of rock residue to a depth of a few feet a very fertile soil is found.

The area of limestone soil is limited by the extent of the drift material; that is, the sands and clays of Lafayette age lap up well on the south side of the Trenton rocks. Near the Cahaba River and on the lower Six Mile Creek some of the limestone has a compara-

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tively shallow covering of Lafayette material, which carries so much chert and other local débris that the soil shows unmistakable evidences of its calcareous origin.

The soils directly derived from the Trenton have been correlated with the Decatur series, which has a more extensive development northeast of this county.

Associated with the Trenton rocks are some very siliceous limestones, whose decomposition has resulted in the accumulation of the chert fragments so numerous in many places. Several square miles of land on the Little Cahaba River consist chiefly of this residue. It is distinguished by the great abundance of chert rock and the highly siliceous character of the fine earth itself. This type—correlated with the Clarksville stony loam—has the local name "Flint Hills," which is frequently applied to this section of the area.

In the northern part of the county the Tuscaloosa and Lafayette deposits are so closely associated that in many instances no very close line can be drawn between them. The Tuscaloosa usually consists of stratified beds of highly plastic clay and fine micaceous sand. Its normal structure in this area is well indicated by the exposures on "Soap Hill." The Lafayette formation, which is of much more recent origin, is here a comparatively thin deposit covering a good deal of the Tuscaloosa. It consists for the most part of materials from the Tuscaloosa reworked into an unstratified sandy clay.

On the high divides the agencies to which the Lafayette owes its origin were not so effective as at lower levels. In many instances the crest of a ridge may consist of Tuscaloosa sand and clay, the original bedding planes showing a foot or two below the surface. Farther down the slope, or where the general surface elevation is less, the surface material to a depth of several yards may have all the characteristics of the Lafayette formation.

In such instances the Susquehanna and Orangeburg soils, which are derived, respectively, from the Tuscaloosa and Lafayette deposits, have a distribution or mode of occurrence depending upon topographic position.

On the watershed between the Warrior and Cahaba drainage systems the Lafayette has a rather limited development. It is found in the valleys and on the lower flanks of some of the less prominent ridges. This is also true of the rough area between the lower Cahaba Valley and the western heads of the Oakmulgee branches.

These soils are chiefly from the Tuscaloosa. The abundance of ferruginous sandstone and quartz gravel is a distinctive feature of the surface, and consequently gravelly loams predominate. In a former[a] classification of the agricultural lands of the State this sec-

[a] Alabama Geological Survey, Report 1881–82.

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tion and some gravelly type to the north of Sandy Creek and northwest of Centerville were appropriately termed "Gravelly hills, with longleaf pine."

The large areas of Susquehanna fine sandy loam owe their origin to the exposures of the clay beds of the Tuscaloosa. The thin covering of fine sand is the result of surface erosion and solution, whereby the finer particles have been removed, leaving the coarser and more resistant ones, the siliceous sand grains, to form the soil.

On the steeper slopes, where erosion is most vigorous, this sandy covering may be removed about as fast as it is formed. In such cases the entire soil section is a clay, forming the type known as Susquehanna clay.

In general the Lafayette deposit, excepting the superficial weathered portion, is a red sandy clay, or more correctly a mixture of fine sand, silt, and clay, with gravel occurring in places. It has a structure especially favorable to the maintenance of excellent moisture conditions. This property is well developed in the Orangeburg soils, and is one important distinction between them and the soils of the Susquehanna series. The higher clay content of the latter and, in many instances, the presence of thin but dense strata of clay in the deep subsoil, is not conducive to an equable water content. The difference in the physical structure of the basic material of the two series is of great importance, but is frequently overlooked on account of the sandy surface of each and the similarity in color.

The high terraces on the west side of the Cahaba Valley and the somewhat lower ones on several of the creeks are of Lafayette age. The soil in these comparatively level areas is finer in texture, containing more than the quantity of silt usually found in any of the other Orangeburg soils. At a much greater elevation in the uplands flat-topped hill remnants of an old peneplain are found. They have a soil very similar to that of the terraces.

Between these elevations the Lafayette deposits, when present, follow closely the inequalities of the old Tuscaloosa surface. On the slopes the processes of weathering mentioned in connection with the development of the Susquehanna fine sandy loam have formed an Orangeburg soil of the same class. It is generally deeper, for the Lafayette material yields more readily to weathering than the Tuscaloosa does.

Some of the more sandy phases of the Lafayette formation have given rise to the Guin series. These soils lack the distinctive red color of the Orangeburg, and usually rest upon a sandy substratum. They are an intermediate series grading on one side into the Orangeburg and on the other into the Norfolk. In Bibb County the latter series is represented by limited accumulations of sand and sandy gravel.

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Several local types are found in the Cahaba Valley. Along the line of contact between the various geological formations the soils are mixed. These transitional types have necessarily been included in some one of the better defined members of the series to which they are most closely related.

Twenty-six types were recognized in this survey. The actual and relative extent of each is given in the following table.

The following table gives the names and areas of the several soil types shown on the accompanying map:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Susquehanna gravelly loam	89,600	22.2	Huntington silt loam	4,160	1.0
Orangeburg fine sandy loam	74,496	18.5	Guin gravelly sandy loam	3,968	1.0
Dekalb fine sandy loam	60,800	15.1	Clarksville stony loam	3,840	1.0
Orangeburg gravelly sandy loam	48,576	12.0	Cahaba fine sandy loam	2,816	.7
Susquehanna fine sandy loam	27,456	6.8	Ocklocknee clay	2,688	.7
Ocklocknee fine sandy loam	13,504	3.3	Norfolk sandy loam	2,432	.6
Rough stony land	12,928	3.2	Guin fine sand	2,304	.6
Guin sandy loam	11,200	2.8	Montevallo shale loam	1,216	.3
Waverly silt loam	9,088	2.3	Susquehanna clay	1,024	.3
Kalmia fine sandy loam	8,256	2.0	Huntington fine sand	896	.2
Greenville fine sandy loam	6,784	1.7	Hanceville fine sandy loam	384	.1
Decatur loam	5,696	1.4	Decatur clay loam	320	.1
Meadow	4,544	1.1	Total	403,200	.....
Cahaba silt loam	4,224	1.0			

GREENVILLE FINE SANDY LOAM.

The soil of the Greenville fine sandy loam to a depth of 6 or 7 inches is a fine sandy loam, loose to very friable at the surface, but more coherent a few inches below. The sand grains are rounded rather than sharp, the fine material consists largely of silt, and the soil has a decidedly loamy character even where there is very little organic matter present. A slight increase of the latter gives the soil a dark reddish-brown color and the appearance of a loam. The surface color of cultivated lands ranges from a light reddish gray to reddish brown.

The subsoil is a brick-red clay loam. Compared with the soil the sand content is low, but there is usually a moderate quantity of the finer grades present. Thin streaks and pockets of rounded gravel occur in the lower depths, and in places the entire soil sections contain more or less small gravel, with occasional iron concretions. As a rule, the color and texture of this material are quite uniform to a depth of 8 or 10 feet. Below this depth beds of waterworn gravel underlie all the lower areas.

The line between soil and subsoil is well defined, and in many old fields the distinction is emphasized by the formation of a hard layer

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just below the plow line. This is due to shallow plowing and marks the impacting of the soil by the pressure of the plow.

The soil is easily cultivated. It is not so loose as to be droughty, nor is it in the least degree difficult to keep in an excellent state of tilth. The subsoil has a structure favorable to the maintenance of a high moisture content and capillarity is good throughout the entire soil section.

The largest areas of the Greenville fine sandy loam are found on the west side of Cahaba Valley. They are the remnants of an old terrace, which has an elevation of 30 or 40 feet above the river channel. The surface of most of these areas is undulating. It rises to the gravelly hills to the westward and usually drops off to the second bottoms in a well-defined bluff. Small areas occur as far south as Harrisburg. The low mounds of red land which are found in the Cahaba soils may be remains of this type which have suffered nearly complete removal. The soil in such areas is usually heavier than the normal phase of the type. The terrace on the north side of Sandy Creek is a very gradual transition between the gravelly hills and the alluvium of the stream. Some of it is not so well drained as the areas on the Cahaba River. The small areas found on the highest uplands have a level surface which drops off rather abruptly on all sides, so that they resemble miniature plateaus.

This is an excellent type for general farming. The average yields of cotton, corn, and oats, as well as of the minor crops, exceed those of the other upland soils. This is due in some measure to the surface conditions, which admit of the use of improved methods of culture, but the moderate depth of the sandy soil and the excellent moisture-holding properties of the subsoil are very favorable to plant growth. Some land has been under cultivation seventy-five years and still produces good crops.

This soil admits of easy improvement by use of commercial fertilizers or manure. Moderate quantities of the latter give it a very dark loamy appearance and the effects are observable for many years.

Nearly all of this soil is cultivated. Some farms are well improved, and the valuation ranges from $30 to $50 an acre.

The following table gives the average results of mechanical analyses of samples of the soil and subsoil of the Greenville fine sandy loam:

Mechanical analyses of Greenville fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18039, 18745.....	Soil.....	0.4	6.3	9.3	32.3	17.1	27.2	7.4
18040, 18746.....	Subsoil.....	.4	3.8	4.5	18.6	11.9	30.6	29.9

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ORANGEBURG FINE SANDY LOAM.

The soil of the Orangeburg fine sandy loam is a light reddish brown fine sandy loam 6 to 15 inches deep. The surface 4 to 6 inches, which is the part directly affected by cultivation, is a light fine sandy loam, with considerable medium to coarse sand. Some of it has a coarse feel when rubbed between the fingers. It is usually incoherent and in many places consists chiefly of brownish gray sand. The virgin soil is much darker colored and more loamy than the cultivated areas on account of the greater content of vegetable matter. The material immediately below the soil contains more of the finer particles and is usually coherent, and retains moisture fairly well. Its color is variable, ranging from brownish gray to reddish brown.

Beneath this occurs the subsoil proper, a red sandy clay or clay loam. It has a granular structure, which makes it a good absorber and retainer of moisture. To this property is due in large measure the agricultural value of the soil. The lighter phases do not possess this quality to a marked degree and are consequently droughty. The processes to which the Orangeburg soils owe their origin have been discussed under the head of soils.

In its wide distribution in this area this soil necessarily varies in its crop adaptations. The large area in the northwestern part of the county is perhaps the most typically developed. It includes some excellent upland soil, well adapted to nearly all the farm crops usually grown in this area. A considerable proportion is yet uncleared. Farther south near Eoline the type approaches in color and texture the Susquehanna fine sandy loam. The soil is a light fine sandy loam with very little coarse material and a decided tendency to assume a very light gray color. The subsoil is a red sticky sandy clay, more or less micaceous and underlain at 5 or 6 feet by clay of the Tuscaloosa formation. This phase also prevails between Six Mile Creek and Randolph.

To the south of the limestone outcrops and also on the western side of the Cahaba Valley the soils are generally rather coarse, in places gravelly. The subsoil is finer textured, including more than the average amount of silt and clay and has a granular structure. Such soils are usually more productive than the lighter phases.

Many of the small areas in the southwestern part of the county are transitional types. They often occur between the heavy Susquehanna soils and the light, sandy Guin types.

In topography, the Orangeburg fine sandy loam ranges from moderately hilly to broken. Where the surface is rough there is usually considerable gravel and great local variations in the depth of the soil.

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The best agricultural land is found on the crests of the divides, but unfortunately such areas are limited in extent.

Cotton is the principal crop grown. The yields range from one-fourth to 1 bale per acre. Considerable quantities of commercial fertilizer and cotton-seed meal are used. The latter is almost a necessity in furnishing the required nitrogen, for there is usually very little organic matter in the soil. This is not considered good corn land. The average yield in old fields seldom exceeds 12 to 15 bushels per acre.

Oats, cowpeas, peanuts, and a great variety of vegetables can be easily grown. The lighter phases are well adapted to peaches and good locations for orchards may be found. Apple trees do not thrive, usually dying before they are 6 or 8 years old.

Should the culture of shaded tobacco be taken up in this area, favorable locations may be found on this soil. That phase which may be described as moderately coarse in texture and open or friable in structure to a depth of 12 or 15 inches, with a red sandy clay or heavy loam subsoil, should be selected. Much of the land is too hilly to be available, and phases approaching the Susquehanna soils should be avoided.

The present value of the land depends upon its topography and location. Moderately rolling cleared land situated on the main roads may be bought at $10 to $20 an acre. Rough uncleared land is valued according to the character and size of the timber. Nearly all was originally covered with a magnificent growth of longleaf pine. The virgin timber has largely disappeared and loblolly pine with a mixture of oak has taken its place.

Mechanical analyses of representative samples of the soil and subsoil of the Orangeburg fine sandy loam are given in the following table:

Mechanical analyses of Orangeburg fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18747	Soil	0.4	2.1	5.6	40.7	13.5	29.6	7.8
18748	Subsoil	.0	1.2	3.8	30.6	10.2	16.7	37.4

ORANGEBURG GRAVELLY SANDY LOAM.

A distinguishing feature of the Orangeburg gravelly sandy loam is the abundance of rounded gravel found in the soil. It consists chiefly of white and pink quartz, and quartzite pebbles an inch or two in diameter, with a small proportion of darker colored rock of more complex composition. On some of the higher ridges fragments

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of ironstone and other ferruginous concretions are numerous, but the fragments of crystalline rock form most of the stony material. As a rule the gravel occurs in the first foot of the soil section; in many places practically all of it is upon the surface.

The soil to a depth of 8 or 10 inches is a rather light fine sandy loam. Usually the greater part of the sand is fine to very fine in texture, and there is a considerable proportion of silt, especially in the lower part. The content of coarse sand is low for a gravelly loam. The color varies from light gray to reddish brown, according to the humus content, and also in old fields is affected by the depth of cultivation. Where the subsoil is partially exposed the surface may have a reddish cast.

The subsoil is a brick-red heavy loam. It usually contains but a moderate quantity of gravel, and much of this occurs in thin bands or occasional pockets. The subsoil of much of the type closely resembles that of the Orangeburg fine sandy loam. It is rather compact, somewhat granular in structure, and retains moisture well.

The greater part of the total area mapped as Orangeburg gravelly sandy loam has a hilly surface, which becomes more broken near the streams or where the type merges into the Susquehanna gravelly loam or into rough stony land. Much of it, however, is moderately rolling, with undulatory areas well adapted to general farming. On the higher points of the ridges the soil to a depth of 15 or 20 inches may consist chiefly of coarse gravel, but such phases of the soil, while very common, are of limited extent. On the steepest slopes surface wash and creep has resulted in greater or less reworking of the material, so that all the hillside may be a sandy gravelly loam 2 or 3 feet in depth, with a coarse sandy clay of reddish yellow color as the deep subsoil.

The heavier phases of this type have almost the same agricultural value as the Orangeburg fine sandy loam. The fertilizer requirements and crop yields are similar. The gravelly land is said to endure drought the better of the two types, the gravel where much or all of it is on the surface forming a mulch. Areas adjacent to the limestone outcrop may have received contributions of material from these formations. Some of the soil north of Centerville is underlain by limestone and occasionally resembles the Decatur soils.

The agricultural value of a given area of the type depends upon its topography. A considerable proportion of the whole is unsuitable for farming on account of high gravel content and the distance from towns. Unimproved land from which most of the timber has been removed may be bought for $5 to $8 an acre. Good locations for peach orchards may be selected and some of the soil seems well adapted to grapes.

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The results of mechanical analyses of samples of the soil and subsoil of the Orangeburg gravelly sandy loam are given in the following table:

Mechanical analyses of Orangeburg gravelly sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18037	Soil	3.0	6.0	4.5	28.8	6.9	44.1	7.0
18038	Subsoil	1.6	4.4	3.3	26.1	7.1	40.9	16.8

SUSQUEHANNA GRAVELLY LOAM.

The Susquehanna gravelly loam is the prevailing type in the western and middle southern part of the county. The broken surface described in a preceding chapter has given rise to variations in the depth and structure of the soil which have a definite relation to topographic position.

On the tops of the ridges and extending well down the slopes the sandy material over the red clay subsoil is seldom more than 8 or 10 inches in thickness. Near the foot of the hillsides and in most of the depressions it has a greater depth and the clayey substratum is modified in color and structure.

These differences in the character of the soil may be found in all the areas of the type, often occurring within a short distance of each other. Considering the type as a whole, however, it is quite uniform in origin and mineralogical composition. With regard to its agricultural value one section of land does not differ materially from another.

The soil of most of this type is a fine to very fine sandy loam. It usually contains considerable silt, and in places approaches a silt loam in texture. The percentage of coarse sand and fine gravel is very low, considering the stony character of much of the surface. The fine earth has a soft, loamy feel. Its color varies from light brown to reddish brown. In the virgin soil the first 2 or 3 inches are usually darker through the addition of decaying vegetable matter. In cultivated fields, or even where the surface is exposed to the sun by removal of the timber, it assumes a much lighter tint.

The subsoil is usually a brick-red clay, similar to that of the Susquehanna fine sandy loam. At a depth of 25 or 30 inches it is a red-and-white mottled clay carrying a good deal of finely divided mica, and a few feet below the surface the red clay grades into thin-bedded whitish clay, resting upon a white, micaceous sand which extends to considerable depths. This sand often shows horizontal beds of nearly impervious clay.

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Through the subsoil and between it and the underlying sand there are one or more irregular sheets of iron-cemented sandstone. These plates vary from a fraction of an inch to several inches in thickness. On the crests of the ridges and on all the highest points these iron crusts—a very hard brown siliceous ore—are very abundant upon the surface. They literally cover the ground in some places, varying in size from coarse gravel to pieces several feet across. On the high divide between Data and Pearson much rounded crystalline gravel is mingled with the ironstone. This is also true of the area south of Lucille and Braehead. The small areas near Piper carry a great deal of quartz gravel and the soil is very sandy.

On the flanks of many of these divides, or where a slight local depression exists, the soil is a somewhat coarser sandy loam from 6 to 12 or 15 inches deep. The subsoil is usually a sandy clay, more open in structure than the residual clay which forms the subsoil of the phase just described. The surface is less incumbered with stones and small areas often occur which are cultivated with considerable success. Generally they are mere patches or irregular strips along the small branches or creeks.

The principal forest growth is longleaf pine and black-jack oak. In the ravines there is a good deal of poplar, post oak, hickory, and sweet gum, with dogwood, sourwood, and cucumber trees as the larger undergrowth. On all of the high ground there is a thin surface covering of wilt vetch, dwarf huckleberry, and sedge grass.

This type of soil has a low agricultural value. It affords good pasturage for sheep, and could be utilized to a much greater extent for this purpose. After the original pine is removed the black-jack oak usually comes in so thick that the native undergrowth disappears and the land is rendered valueless for pasture.

Several of the large areas in the western part of the county have a valuation ranging from $10 to $20 an acre, according to the quality of the standing timber. The areas near the center of the county have largely been cut over and the land is worth but a few dollars an acre.

The following table gives the average results of mechanical analyses of fine-earth samples of the Susquehanna gravelly loam:

Mechanical analyses of Susquehanna gravelly loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18755, 18758	Soil	1.9	4.4	4.2	20.4	27.4	31.9	9.6
18756, 18759	Subsoil	.0	.8	.7	10.6	12.9	26.7	48.1
18757, 18760	Lower subsoil.	.2	.8	.6	10.2	13.6	29.2	45.1

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SUSQUEHANNA FINE SANDY LOAM.

The soil of the Susquehanna fine sandy loam consists of a fine sandy loam of variable depth. There is a marked absence of the coarse grades of sand. The silt content is usually high and a perceptible amount of finely divided mica is present. The material has a fine, smooth texture, is rather loose in structure, and if it contains more than the average amount of humus it is very loamy and friable. The surface color is gray, tending to reddish brown with depth.

The subsoil is a heavy, tenacious red clay. When dry the exposed surface of this material in roadside ditches crumbles into very hard, angular lumps a fraction of an inch across. When wet this clay is exceedingly adhesive, and if well saturated becomes very soft and so yielding and slippery that it is aptly termed "soapy." This peculiar quality is due in some measure to the high percentage of mica which it contains.

At a depth of 2 to 3 feet the red subsoil is underlain by lighter-colored clay which is more or less stratified. This stratification may consist of thin bands of white, micaceous clay of very fine texture, or of flakes of similar material arranged horizontally in a matrix of red clay. This light-colored clay is nearly impervious, a thin layer being sufficient to affect seriously the underdrainage. It occasionally occurs as a heavy bed several feet thick. In such cases the subsoil is merely the weathered upper portion, the iron content being highly oxidized.

In some instances the lower subsoil is a mottled red and white silty clay, becoming more sandy with depth. This graduates downward to a white micaceous sand, which gives better underdrainage, provided the subsoil is not more than 3 or 4 feet in depth.

The distinguishing feature of this type is the heavy red subsoil. It affects the agricultural value to a marked degree, since the sandy loam of the surface is generally too thin to mask the characteristics of the clay. In old fields where considerable erosion has occurred the clayey material is exposed in many places. These red spots show very plainly where the ground is freshly plowed, and their location is indicated later in the season by the thin stand and dwarfed appearance of the cotton and corn plants. Such phases of the type are difficult to keep in good tilth. In wet seasons they are so miry that cultivation is practically impossible, and on drying the surface becomes very hard. In the depressions, where washings from the adjacent hillsides have accumulated, the soil is very loamy and responds generously to good tillage.

The Susquehanna fine sandy loam near Randolph occupies the crests of some rather broad divides. A considerable proportion of the entire area is moderately undulating and the soil has a depth of 8

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to 12 inches. Such phases are well adapted to cotton. They endure drought well if properly managed and with an increase of the humus content produce good crops of corn.

In the areas south of Ingate some very loamy phases of the type are found. There are also considerable tracts of land which have been abandoned or are used only for pasture.

The large area between the heads of Sandy and Copperas creeks is very broken and of little agricultural value. The areas north of Eoline include the crests of some narrow interstream divides. The soil is thin and erodes badly. Much of it apparently consists of very fine, well rounded quartz grains with less than the usual proportion of clay and silt. In all old fields and in some of the uncleared land in this vicinity the organic matter content is very low and the soil has a peculiar white, "lifeless" appearance.

The native vegetation consists chiefly of deciduous trees. Hickory and several varieties of oak are abundant. On the high ridges some longleaf pine is interspersed with these varieties, but it avoids the heaviest phases. In the ravines and along the streams poplar, swamp pine, sycamore, maple, gum, and cucumber trees are found.

Much of this type formerly under cultivation has been abandoned. Old fields now grown up in loblolly pine are rather common. Their cultivation was discontinued after the original humus supply was exhausted and erosion had removed much of the sandy loam. If shallow plowing is practiced for a number of years, the subsoil becomes very compact at the plow line. On a steep hillside a single heavy rain will occasion irreparable injury by washing away most of the light soil. Terracing and deep plowing will prevent some of this waste.

Much of this type is not permanently productive. The phases that most closely resemble the Orangeburg soils are possible exceptions. In most instances the light-colored fine sandy lands having the unweathered clay more or less in evidence at a depth of 2 to 3 feet rapidly decline in crop yields after a few years of cultivation. The cultural difficulties already pointed out are the chief causes of this decrease in productiveness, but where a good physical condition is maintained the yields do not compare favorably with those on the Orangeburg types. This is doubtless due to some property of the Tuscaloosa clay from which the soil is derived.

The best phases of this type will produce from one-half to 1 bale of cotton per acre. Corn yields from 10 to 20 bushels. Where the soil is thin and clayey, winter oats and rye succeed, furnishing not only good pasture, but also much-needed cover crops. Much of this land could be profitably utilized in the production of forage crops. If the growing of Japan clover and Bermuda grass were encouraged, good pasture could be cheaply obtained.

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The value of improved land ranges from $10 to $15 an acre. Very rough land is valued according to the timber upon it.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of this type:

Mechanical analyses of Susquehanna fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18749	Soil	0.4	1.1	4.3	32.5	21.0	32.0	8.7
18750	Subsoil	.0	.3	.4	18.9	9.1	20.8	50.5
18751	Lower subsoil.	.0	.1	.2	13.3	8.0	28.3	49.9

SUSQUEHANNA CLAY.

A few small areas of the Susquehanna clay have been mapped. It is essentially the subsoil of the Susquehanna fine sandy loam from which all the lighter surface material has been removed.

The area around Randolph is a high ridge from which the original surface soil has been eroded since the land was cleared. The other areas include both old fields and virgin land. The latter generally has a thin covering of fine sandy loam, which on the steeper slopes has been held in place by forest growth.

In all the cultivated areas of the Susquehanna fine sandy loam small spots of this type may be found, but no attempt has been made to show them on the map.

The heaviest phases of this type are practically untillable. At certain stages in the moisture conditions of the first foot or two it yields fairly well to cultivation. It should never be worked or trampled over when wet.

Since clay soils in general are best adapted to grasses, much of this type could be well utilized for forage crops or pasture. It is highly probable that a heavy application of lime would assist in securing a stand of mixed grasses and clover. Permanent pasture could be secured on many of the old fields now supporting practically nothing of value.

GUIN GRAVELLY SANDY LOAM.

The Guin gravelly sandy loam to a depth of 10 to 15 inches is a sandy gravelly loam very loose and open in structure. The surface in most places is covered with small stones and gravel. The latter consists almost entirely of the rounded quartz pebbles so common in the middle and southern parts of the county. The larger stones are the flat, iron-cemented sandstones, but as a rule they are not abundant

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in this soil. A few inches below this surface the material is much heavier, being usually a coarse yellow sandy loam with pebbles distributed through it.

The subsoil is a yellow or reddish-yellow sandy clay with varying amounts of coarse sand and gravel. In most instances the lower part of the soil section grades into the sands or clays of the Tuscaloosa formation. On some of the ridges a thin crust of iron may lie between the two at a depth of 3 to 4 feet. In the depressions and on the flanks of the larger divides the Guin gravelly sandy loam is a colluvial soil having considerable depth. It is usually very open and readily leached by the rain water. This characteristic, together with the rough topography, renders the type as a whole of little agricultural value.

The native vegetation consists chiefly of longleaf pine with more or less black-jack oak on the sandy phases, and under present conditions it is best adapted to forestry. Some of this soil is well adapted to peaches and pears. Grapes have been grown with considerable success, but the distance from market and the inaccessibility of most of this type renders it unsuitable for such purposes.

NORFOLK SANDY LOAM.

The Norfolk sandy loam, to a depth of 12 to 15 inches, is a medium to fine sand or a very light sandy loam. There is a small percentage of coarse sand and some gravel present, which shows very plainly in old fields after a rain. The color is light gray. After the original organic matter content is exhausted, which occurs a few years after the land has been put under cultivation, the surface has a decidedly bleached appearance. The light color and coarser texture of the type distinguishes most of it from the Orangeburg and Guin soils. It seldom contains iron crusts or other ferruginous material, consisting chiefly of siliceous sand. The subsoil is a yellow sandy clay, becoming heavier with depth.

Small areas of this type are found in the southeastern part of the county. Portions of these areas are cultivated, chiefly to corn and cotton, but the average yields are low. The former seldom exceeds 10 or 12 bushels per acre, and the latter averages about one-half bale. Winter oats do well, and some of the type could be profitably used for this crop. If followed by cowpeas the organic matter content would be increased so that the soil could better withstand drought and the following crops of corn and cotton would be benefited. This light soil is well adapted to truck crops, but owing to present lack of market facilities these can not be profitably grown. On this type a fine quality of sugar-cane sirup of superior flavor and color can be produced.

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GUIN SANDY LOAM.

The Guin sandy loam is a gray to grayish-brown sandy loam. While the finer grades of sand predominate, there is generally a perceptible amount of medium sand and sometimes enough coarse grades to give a decidedly gritty feel to a sample when rubbed between the fingers. It contains sufficient silt and clay to be coherent when wet, but when dry is very friable and in most instances plows into a loose, deep seed bed, the surface never becoming cloddy.

The contact between the soil and subsoil is generally well marked by the difference in color and structure. Below 8 to 10 inches the material is a dull reddish-brown or yellow-brown color, which prevails to a depth of several feet. To a depth of 18 to 20 inches the content of clay and silt increases, giving the material more coherency and firmness than the soil possesses. The sand seems to average a little coarser in texture. Below 20 inches the relative proportion of sand increases with depth, and the lower subsoil is usually a light sandy loam.

In this area the Guin soils represent a rather broad transition between the Orangeburg and Susquehanna series. The material forming the Guin series should be classed geologically with the Lafayette formation rather than with the Tuscaloosa. It seems to have undergone the same method of deposition as the former, perhaps the only difference being that its constituents are chiefly of local origin and include a relatively greater percentage of sand. The latter gives the coarser texture and more open structure which the Guin soils present when compared with the Orangeburg. The freer circulation of air and water may have affected the iron content, producing brown instead of red tints. Local variations in color are of frequent occurrence. In general, the heavier phases of the subsoil have red or reddish tints, while the lighter textured ones incline to gray and brown. The organic matter content is low, affecting only the color of the immediate surface.

The topography varies from undulating to hilly. Its average elevation is less than that of the other upland types. Some small areas resembling the Kalmia fine sandy loam are found along the minor streams. On some of the higher ridges the type graduates to the Guin fine sand.

This type is not highly esteemed for general farming. It does not withstand drought well, and in wet seasons the comparatively rapid percolation of water tends to leaching. Farmers complain that it will not "hold fertilizers."

Being light and well drained the type is adapted to early truck. Near Blocton considerable produce of this kind is grown for local markets, besides melons, sweet potatoes and tomatoes. Peaches and grapes are grown with considerable success.

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This soil would be greatly benefited by liberal additions of vegetable material, preferably some green crop plowed under. This would correct the deficiency in organic matter, or humus, and by increasing the loaminess of the soil would make it more retentive of moisture. The latter is even more essential than the former. By gradually increasing the depth of plowing some of the clay subsoil would be added to the surface soil and this would also increase the moisture-holding capacity of the soil if shallower cultivation be followed.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of this type:

Mechanical analyses of Guin sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18735	Soil	0.8	13.3	18.8	30.5	7.7	18.3	10.5
18736	Subsoil	.4	11.6	16.5	27.2	6.7	22.1	15.3

GUIN FINE SAND.

The Guin fine sand is a somewhat anomalous type associated with the Susquehanna and Guin soils. It represents local accumulations of sand, mostly of the finer grades, evidently derived from the arenaceous strata of the Tuscaloosa formation. It is most commonly found on the high divides, but some small areas occur on the flanks of hills. In many places in the vicinity of Pondville the Guin sandy loam passes gradually into this type, but the areas are too small to map.

The soil as mapped is generally a loose, incoherent, grayish sand 10 to 15 inches deep. In the areas that are low in organic matter content the surface soil is very light colored. The subsoil is a fine sand, somewhat more loamy than the surface. Upon its capacity to absorb and hold moisture depends the crop-producing power of this type. In most places it is open in structure and so deep that it rapidly loses moisture; consequently this land has a low agricultural value. Where the subsoil consists of a fine loamy sand, bright red in color, good cotton may be grown in seasons of average rainfall. Winter oats would do well and could be followed by an early crop. This phase of the type is very susceptible of improvement and should be more generally utilized in the production of forage crops.

The small area northwest of Eoline occupies some high ridges, mostly covered at the present time with longleaf pine and blackjack oak. It is generally lighter colored than the areas near the Guin

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soils. The subsoil in most places is a dull brownish-gray sand or very light sandy loam of unknown depth.

Owing to the variable nature of this type, no samples were collected for mechanical analysis.

KALMIA FINE SANDY LOAM.

The Kalmia fine sandy loam is a light-brown fine sandy loam, having a depth of 6 to 7 inches. The percentage of medium to coarse sand is usually low, while that of silt is quite high, giving the material a decidedly loamy character.

After a heavy rain it packs to a moderate degree of firmness, and the surface has the appearance of a loam. Under usual moisture conditions the cultivated soil is very friable as deep as it has been plowed. The lightest phases of the type are a loamy sand 10 to 15 inches deep. If deficient in humus, they are very light in color. These sandy phases constitute but a small proportion of the total area.

The subsoil is much heavier than the soil. In most instances it is a silty clay containing considerable medium and fine sand. It extends to a depth of several feet without marked change in color or texture. As a rule the lowland has a heavier subsoil than that occupying greater elevations. In the latter positions the deep subsoil is similar to that of the Orangeburg soils.

While the composition may vary from a heavy fine sandy loam to a sandy clay the structure and color are more uniform, the latter being a light brownish yellow, frequently a tint suggestive of ground ginger. The subsoil is more porous than the red material underlying the Orangeburg soils. During rainy periods in the winter the fields are miry, although the surface may have every appearance of a rather firm loam.

The "spongy" nature of the subsoil seems to prevail to a considerable depth. It enables this material to absorb a large amount of water and on the heaviest land cultivation is sometimes delayed in the spring. The type, as a rule, withstands drought well if given proper cultivation.

This soil is typically developed on the gently sloping areas found on the east side of Cahaba Valley. It is associated with the Greenville fine sandy loam and frequently marks the transition between this type and second bottoms. Several large bodies are located between Brent and Harrisburg.

On the smaller streams it usually occupies fairly well defined terraces and extends some distance up the moderately sloping hillsides. On Haysoppy, Affonee, Blue Guttee, Oakmulgee, and the upper tributaries of Six Mile Creek areas are found varying in size from mere strips along the base of a hill to tracts of several hundred acres.

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The type also occurs on the uplands in or near shallow basins found in a few instances at the extreme heads of drainage lines.

This soil is derived from the Lafayette formation. It represents material which has undergone more or less local transportation and upon redeposition has not settled as compactly as in the original state.

The iron content has also been changed. The freer circulation of the ground water, combined with the comparatively high organic matter content of the virgin soil undoubtedly caused the change in the form of the iron oxide in the material to a depth of several feet.

This is a desirable type for general farming. While most of it has sufficient relief to give good drainage none of it washes badly. The light soil is easily tilled and well adapted to cotton growing. These features commend it to the large land owners who must necessarily employ negro labor. In favorable seasons the average yield of cotton is upward of 1 bale per acre. Many fields in the Cahaba Valley have been continuously planted to cotton for ten or fifteen years and still give good returns.

All of this soil with the exception of that recently cleared is deficient in humus. The yields of corn and cotton are increased by applications of cotton-seed meal. Some farmers use a little high-grade acid phosphate in combination with the meal with good results. The readiness with which most of this type responds to fertilization is due in some measure to the excellent physical condition in which the soil may be kept. No fertilizer is lost through excessive leaching or rendered unavailable by bad surface conditions.

The minor crops, such as oats, cowpeas, sorghum, sweet potatoes, and peanuts, in addition to garden vegetables, are successfully grown. Some of the lighter phases are well adapted to the production of sugar-cane sirup of excellent quality.

Much of this type is included in large plantations which are not for sale. The smaller areas are so generally associated with other types of soil that an accurate estimate of their value can not be made. It may be stated, however, that very little cleared land can be bought for less than $30 or $40 an acre.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of this type:

Mechanical analyses of Kalmia fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18727	Soil	0.7	9.6	13.4	34.1	8.3	28.3	5.1
18728	Subsoil	.6	4.2	9.5	21.9	6.9	30.4	26.7

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DEKALB FINE SANDY LOAM.

The Dekalb fine sandy loam to a depth of about 10 inches is a very light yellowish-gray to yellowish-brown silty loam or very fine sandy loam. The surface of cultivated fields is usually lighter in color than the soil a few inches below, and, when dry, has a slightly ashy appearance. It is very friable and only where the silt content is usually high has it any marked tendency to pack after rains.

The content of fine sand is variable, being influenced by the character of the underlying rock and by surface configuration. On the steeper hillsides the soil is generally lighter in texture than on the tops of the divides or on the more moderate slopes. Where the organic matter content is above the average the soil is very loamy and may be easily kept in good tilth.

A relatively large proportion of this soil consists of bits of brown weathered sandstone ranging in size from small angular grains to flat pieces an inch or two across. They give the surface of some of the cultivated land a gravelly appearance and impart a coarse, lumpy feel when rubbed in the hand. Near Blocton much of this stony material is an arenaceous shale rather than sandstone. Some rounded crystalline gravel and ferruginous concretions are found on the higher ridges.

The subsoil is a silty clay loam or silty clay, usually becoming heavier at a depth of 25 to 30 inches. It is less friable than the soil, but is not very compact. Under the prevailing moisture conditions it is crumbly, although it does not have a pronounced granular structure. The structure of the subsoil as a whole is affected by the presence of a large proportion of rock fragments in various stages of disintegration. With increased depth the stones are larger, less affected by decay, and at 2 to 3 feet below the surface constitute most of the soil mass. At 5 feet or less solid rock is usually found.

Where the rock has a shaly structure the subsoil is usually a yellowish colored material. This color is common to the small semialluvial areas where the drainage is poor. The more massive phases of the sandstone contain considerable iron and as they disintegrate assume a reddish color. The further the process of decay proceeds the more pronounced this tint becomes. Pieces of rotten rock which may be easily broken in the hands are light red. The more thoroughly decomposed material is generally yellowish red, and this is the usual color of the subsoil. This is strictly a residual soil derived from a sandstone formation of the Coal Measures.

As already suggested, local variations in the nature of the rock occur, but they do not materially change the character of the soil. Between Pratt Creek and Hargrove much of the rock is rather coarse in texture and the soil is a deeper red in color and more sandy than

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farther north. On Shades Creek and on each side of the Cahaba River it is light in texture and frequently stony.

This type occurs in one large area in the northeastern part of the county. It is well drained by several creeks and many small branches which empty directly into the Cahaba River. Most of these flow through rather narrow gorges, with more or less outcropping of sandstone along the lower hillsides. The upper portion of many of the ridges are moderate slopes and a considerable part of their area can be cultivated.

Nearly all of this type is covered with a second growth of oak, hickory, and a few other varieties of hardwoods. The longleaf pine, never abundant, has been removed and used in the mines. The undergrowth includes a considerable variety of grasses and more herbaceous plants than are commonly found on the Orangeburg and Susquehanna soils. The native pasturage, in many places, is very poor, owing to the density of the black-jack oak.

Most of this land is owned in large tracts by companies interested chiefly in mining coal. Its agricultural possibilities have hardly been determined. On the small farms in the little valleys, where there is more than the average depth of soil, cotton, corn, and a limited variety of vegetables are grown with fair success. In Blocton there are many gardens located on this type of soil. Receiving no other fertilization than liberal applications of stable manure, they produce a great variety of vegetables. While these highly cultivated plots are affected by drought, they will withstand a short period of dry weather much better than poorly cultivated land, causing the latter to be frequently referred to as an entirely different type. This difference is due to the better moisture-holding properties of the soil containing the greater amount of humus and receiving more frequent surface cultivation.

Grapes do well on this type; also apples, plums, and small fruits. On the ridges where good air drainage is assured, and where the soil has a depth of 3 to 4 feet, strawberries could be successfully grown. The soil should be heavily manured, and planted in corn, potatoes, or some other cultivated crop the preceding seasons. In preparing the land for these plants, deep plowing is absolutely essential. This should be done in the fall, in order to conserve as much of the winter rainfall as possible. It is necessary to have the ground in a high state of cultivation before setting the plants, and subsequent tillage should be frequent and done with a view of conserving moisture in the soil.

The same observations apply equally well to other truck crops on this particular type. The soil has not sufficient depth to render it capable of maintaining a high moisture content, but this in a measure can be remedied by proper tillage.

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The excellent local markets afforded by the mining towns justify the expenditure of more labor than is profitable where products must be shipped long distances.

The type does not seem to be well adapted to peaches. No special attention, however, has been given to their cultivation or to the selection of varieties adapted to this locality. Sweet potatoes do well on this soil; also forage crops of all kinds.

Locations may be found well adapted to fruit and truck raising for local markets, but the type is not well adapted to general farming.

A few miles north of Centerville there is a little valley on the east side of the Cahaba River, opening on the north into the gorge of the river. It is entirely surrounded by high hills. The floor of this basin is an outcrop of subcarboniferous shale, part of which, at least, is calcareous, giving rise to a residual soil, which represents a phase of the Dekalb fine sandy loam. The soil approaches a yellowish clay loam, and is rather stiff, but not inclined to be cloddy. Shale fragments are numerous and in some places very abundant. The subsoil is a yellow silty clay, becoming heavier with depth. It contains more or less stony material, the amount varying considerably in different parts of the valley. Most of this phase is cultivated, producing fair yields. Cotton does not attain a large size, but the plants are strong and yield well. This heavy phase is better adapted to grasses. It is probable that clover and alfalfa could be easily grown.

The average results of mechanical analyses of samples of the soil and subsoil of the Dakalb fine sandy loam are given in the following table:

Mechanical analyses of Dekalb fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18731, 19068	Soil	3.3	3.9	2.9	18.7	16.9	38.8	15.4
18732, 19069	Subsoil	.9	3.1	1.2	3.3	6.5	45.6	39.3

HANCEVILLE FINE SANDY LOAM.

A small area of the Hanceville fine sandy loam is found in the northern part of the county on the divide locally known as "Sand Mountain." This is an elevated ridge of light-colored sandstone, much harder than the rock to the south from which the Dekalb fine sandy loam has been derived, the weathered outcrops, consisting usually of large rounded masses of graystone, forming areas of Rough stony land on each flank of the "Mountain." On the top a residual soil has accumulated to a depth varying from a few inches to many feet.

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The virgin soil is a friable fine sandy loam. The upper portion is dark gray in color through the addition of organic matter. At a depth of a few inches it is more compact and changes to a reddish loam. It contains considerable medium and some coarse sand which is "sharper" than that usually found in other soils of this area.

The subsoil is a compact sandy clay of a bright Indian red color, usually becoming heavier with increase of depth. In many instances, however, the contact between the soil and subsoil is sharply indicated by the marked increase in clay at 8 to 10 inches below the surface, while the deep subsoil is rather sandy. When wet this sandy clay is very plastic, and if handled stains the fingers red. When dry it becomes very hard, the high clay content serving to cement the sharp sand very firmly.

On the limited area under cultivation all field crops common to this county are grown. It seems to be well adapted to tree fruits, and a few very old apple trees are on this type. The elevation insures immunity from the frosts which damage trees on lower land.

This soil is exceptionally responsive to careful management. In its cultivation the conservation of moisture should be given much consideration. The soil body will absorb and hold a heavy rainfall, but in old fields, where the organic matter content is low, the surface packs and evaporation is very rapid. Deep plowing and frequent shallow cultivation would be beneficial. The effects of heavy applications of manure are observable for many years afterwards.

The following table shows the results of mechanical analyses of a sample of the soil and subsoil of Hanceville fine sandy loam:

Mechanical analyses of Hanceville fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18761	Soil	0.7	5.5	11.8	27.0	8.3	35.2	11.3
18762	Subsoil	.3	3.1	7.9	17.6	7.6	22.4	41.1

MONTEVALLO SHALE LOAM.

The Montevallo shale loam to a depth of several inches is a friable silt loam. It usually contains a relatively high percentage of very fine sand, besides numerous angular bits of soft brown shale.

The subsoil is a heavy silty loam or loam and in many instances a rather stiff clay which would doubtless be very compact were there no shale fragments present. These increase in size and abundance with increase of depth. Hillside washes 3 to 4 feet deep show the lower subsoil to be a mass of small, rhomboidal pieces of shale with little interstitial material.

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The color of most of this type is a purplish brown, but gray and yellowish tints also occur. Near Shoal Creek cultivated hillsides show marked variations in color and texture, due to the varied composition of the parent rock and to the admixture of material from the Coal Measures to the north.

This soil is derived from the Montevallo shales,[a] a compact argillaceous rock of the Cambrian age. The exposed portions all show the effects of the displacement to which it has been subjected. The rock is so broken by fracture planes and sharp folds that it breaks down rather rapidly, forming hills of moderate height and easy slopes.

These shales are usually purplish brown in color, and in some instances a dull Indian red, while bands of greenish gray and gray also occur. Occasional lenses of impure limestone and thin sandstone are found in the northeastern exposures in this county.

A series of exposures occur from Shoal Creek almost to Centerville. So much of the formation is concealed beneath the Lafayette material that the total area of this soil is limited to less than 2 square miles.

This is a productive soil wherever it has sufficient depth to maintain a fair degree of moisture. On the hillsides it is generally so shallow that a brief period of drought causes serious injury to crops. Some fields have been cultivated without regard to the effects of surface washing, and consequently they are now practically worthless except for pasture or forestry. In the depressions, where physical conditions are more favorable, corn, oats, and vegetables do well. Apple and plum trees, as well as grapes and small fruits, seem to thrive better on this soil than on the Orangeburg types.

While much of the Montevallo shale loam is too thin and droughty to be safely planted to field crops, limited areas may be found suitable for small farms where the adjoining areas of rough land afford opportunity to raise cattle and sheep. This type ranges in value from $5 to $10 an acre.

Mechanical analyses of a representative sample of the soil and subsoil of the Montevallo shale loam give the following results:

Mechanical analyses of Montevallo shale loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18739	Soil	6.1	9.9	2.9	7.2	12.8	51.6	9.5
18740	Subsoil	3.3	11.5	4.4	8.6	9.9	39.0	23.1

[a] Sometimes called Choccolocco shales. In Report on Valley Regions of Alabama, Alabama Geological Survey, termed "Montevallo shales and sandstones." In Shelby County same formation includes sandstones, shales, and limestones. In Gadsden folio the formation is termed "Conasauga shales."

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CLARKSVILLE STONY LOAM.

The Clarksville stony loam to a depth of 10 to 12 inches is a very light gray silty loam. It usually contains such a high percentage of gray chert fragments, varying in size from fine, sharp gravel to large stones, that the texture of the soil is obscured. The fine earth, however, consists chiefly of silt and fine sand, with a rather small percentage of clay. When dry this soil has a light, fluffy feel, is barely coherent, and if devoid of humus is almost white.

The subsoil is a light-yellowish silty loam, with a higher percentage of clay. It contains so much chert that any implement penetrates with considerable difficulty below a depth of 1 or 2 feet. Solid rock, however, is seldom found, and the same general admixture of fine silty earth and broken rock extend to a depth of many feet.

A small area of this type is found west of Four Mile Creek, lying between this stream and the Little Cahaba River. It is associated with outcrop of the Trenton limestone and near the other streams grades to Rough stony land. Indeed, no very definite line can be drawn between the two types.

A little of the Clarksville stony loam is under cultivation. It produces good crops of cotton, corn, and potatoes while the original supply of humus lasts. When this is exhausted the soil tends to run together after each rain. In such condition it dries out rapidly. The type as a whole is difficult to cultivate and has a low agricultural value. The same soil type farther north has been found well adapted to peaches and affords sites for commercial orchards.

While this soil is not calcareous, it has been affected locally by the adjacent limestone, some of the depressions having received contributions of rock fragments and other wash from such sources. The lower ground would be better adapted to clover, Johnson grass, and possibly timothy, than to cultivated crops.

Mechanical analyses of a sample of the type taken south of Six Mile Creek give the following results:

Mechanical analyses of Clarksville stony loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19062	Soil	2.9	8.7	6.4	17.2	10.7	42.5	11.3
19063	Subsoil	2.6	6.0	6.7	15.1	7.4	44.3	17.7

DECATUR LOAM.

The Decatur loam to a depth of about 6 inches is a dark reddish-brown loam or fine sandy loam. The latter is the prevailing phase

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on the higher elevations and the hillsides, which are capped with Susquehanna or Orangeburg soils. In the depressions the soil is usually a very dark reddish-brown loam, containing enough clay, especially a few inches below the surface, to render the material quite sticky. As a rule, this phase is friable, easily cultivated, and held in high esteem for corn and cotton.

The subsoil is a dark-red clay loam. The contact between it and the soil is generally well defined. Where there is more or less admixture of sand, evidently from the Orangeburg soils, the subsoil is rather crumbly and in some instances friable to a depth of 15 to 20 inches, but the lower subsoil is compact. Where it rests directly upon the limestone it is a heavy, red, granular clay.

The surface is generally free from pebbles and stones, with the exception of areas along some of the streams where the limestone outcrops.

This soil is derived in the main from the decomposition of the Trenton limestone. In places the residual products have suffered transportation, and more or less material from other sources has become incorporated with them. This is the case on the flanks of divides, where the limestone shows occasional traces of its presence for one-half or two-thirds of the distance up the hillsides, while sand and pebbles of Lafayette origin form the surface soil of the upper portion.

On both the Cahaba and Little Cahaba rivers there are occasional small areas, evidently old terraces, having an elevation of from 50 to 100 feet above the streams. The surface, being undulatory to moderately rolling, is characterized by numerous irregular depressions suggestive of limestone sinks, which in all probability they are. In such localities the Decatur loam is typically developed. The soil is not uniform in texture, but the subsoil is invariably a heavy red clay of limestone origin.

The original timber growth was characterized by an abundance of hickory, white oak, red oak, and red cedar. No longleaf pine grows on this type, but abandoned fields are soon overrun with loblolly pine.

Excellent crops of corn, wheat, and oats have been grown on this soil. The greater part of the cultivated area is now planted to cotton, the loamy depressions producing good yields, but the more sandy upland phases, if not well tilled, are affected by drought.

Some of this type is well adapted to alfalfa. Well-drained land having evidences of a comparatively high lime content should be selected rather than the sandy areas bordering the Orangeburg soils. Too much stress can not be placed upon the importance of preparing a good seed bed in the case of this type of soil. The hard sub-

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stratum, found in some places 6 to 8 inches below the surface, should be broken by deep plowing. Much of this clay will become mixed with the soil, which should be thoroughly harrowed or disked to prevent clodding. Land which is especially deficient in humus would require a light application of barnyard manure unless cowpeas had been previously grown. It is also probable that inoculation would be necessary in order to get satisfactory results with the leguminous crops at first.

In general, the cultivation of this soil requires heavier implements than are at present in use on the fine sandy loams. Some fields have been abandoned largely on account of the unsatisfactory results following the use of light plows and bull-tongue cultivators. Subsoiling appears to be especially beneficial. It was observed in one instance that the moisture content of subsoiled land was much greater than that of the same type near by which had not been so treated.

This type is well adapted to general farming. It also admits of the adoption of a crop rotation without cotton in which corn and oats would be the principal crops. Any of the legumes grown in this area could also be included with favorable chances for the culture or introduction of other forage crops. In many instances meadows or pastures of Bermuda grass and Japan clover could be easily established, the last-mentioned legume doing exceptionally well. Red clover also grows naturally on this land.

The average results of mechanical analyses of samples of soil and subsoil of this type are given in the following table:

Mechanical analyses of Decatur loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19064, 19066	Soil	0.6	7.1	11.4	26.2	11.1	28.5	15.1
19065, 19067	Subsoil	.7	6.3	7.1	16.1	7.3	27.7	34.7

DECATUR CLAY LOAM.

The Decatur clay loam in its virgin state is a dark-colored clay loam to a depth of 6 to 8 inches. The top soil is much lighter in texture than the material 3 to 4 inches below the surface. The latter is usually a stiff granular clay or clay loam. It gradually changes with increase of depth to a dark-red residual clay similar to the heaviest phases of the subsoil of the Decatur loam.

Small areas of this type occur along the Cahaba River, most of them being too small to map. The largest tract of such land is found near River Bend, occupying a moderately elevated area underlain by limestone.

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This type is essentially a residual soil containing but little material other than that of limestone. It has practically the same agricultural value as the Decatur loam.

CAHABA SILT LOAM.

The Cahaba silt loam is a light-yellowish silt loam or silty clay loam. The surface of the uncultivated land is rather compact. It contains more or less fine sand and little or none of the coarser grades. The organic matter content is also low—another cause of the compactness characteristic of the soil. If plowed when wet it is cloddy, but if cultivated at the proper time with regard to the moisture conditions the surface material is friable, or at least crumbly, and assumes a condition suitable for any crop.

There is no line of demarcation between the soil and the subsoil. The latter contains more clay and is quite compact, and its color is bright yellow. In some places it is distinctly a silt loam, in others it is a silty clay. Some of the areas in the lower Cahaba Valley in this county are nearly level and not so well drained as the small areas farther north. The soil of the latter usually contains more sand and the subsoil is a reddish-yellow silty clay. The red color of the subsoil is more noticeable near areas of Greenville fine sandy loam. Nearer the south county line the two types are less distinct.

This type is found on the second bottoms of the Cahaba River. It owes its origin to the deposition of sediments when the river flowed at a slightly higher level. It is probable that there is little difference in the mineralogical composition of this soil and the Huntington silt loam. The better drainage and the longer period to which the Cahaba soil has been subjected to the agencies of weathering have brought about changes in color and also in structure.

The original vegetation comprised white oak, water oak, ash, hickory, maple, swamp pine, and beech. There was also a heavy growth of cane in many places.

Nearly all of this soil is now cleared and much of it has been under cultivation many years. The high degree of permanent fertility possessed by the Cahaba soils is evidenced by the good yields of cotton on land which has been planted to that staple for years in succession. Some commercial fertilizer is now used and cotton-seed meal is applied, but neither are considered absolutely necessary. If a liberal supply of vegetable material were mixed with this soil its loaminess would be greatly increased and its physical condition immeasurably improved. Under such management the need for commercial fertilizers would be greatly reduced.

There seems to be no reason why alfalfa should not do well on the better-drained areas of this soil. The seed bed should be well pre-

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pared, care being taken not to work the ground when it is wet. The finely pulverized soil makes a good surface mulch, retaining the moisture and insuring germination of the seed without covering it deeply. It is probable that an application of several hundred pounds of lime to the acre would be beneficial and that inoculation of the soil would be necessary.

Japan clover and a variety of grasses and herbaceous plants spring up on all the fields which are thrown out of cultivation for a year or two, forming good pasture.

The average crop yields on this type are perhaps more variable than on the Cahaba fine sandy loam. It is more difficult to manage in wet seasons and more labor is required to keep it in good tilth, for if the surface becomes compact the entire soil section loses moisture rapidly through evaporation. Deep plowing with frequent shallow surface cultivation is recommended.

This land is recognized as a desirable type for general farming. Its value is about the same as the Cahaba fine sandy loam.

Mechanical analyses of a representative sample of the soil and subsoil of this type gave the following results:

Mechanical analyses of Cahaba silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18729	Soil	0.0	1.0	0.5	8.1	14.6	57.2	18.4
18730	Subsoil	.0	.3	.3	10.9	14.1	51.8	22.4

CAHABA FINE SANDY LOAM.

The Cahaba fine sandy loam to a depth of 6 inches consists chiefly of fine sand and silt. The clay content is low and there is usually present very little coarse and medium sand. It is barely coherent when moist and has a particularly soft, loamy feel. Under usual field conditions it is very friable, seldom becoming much compacted, and an excellent seed bed may be prepared with a minimum of labor. The color is usually some shade of brown, tending to a reddish brown on slight elevations or wherever the type borders areas of the Greenville fine sandy loam.

The subsoil is usually a reddish-yellow silty loam, becoming heavier with depth. The line of contact between it and the soil is generally well defined. In old fields where shallow plowing has been practiced there is a compact substratum just below the plow line. In some places the lower subsoil is a yellowish-brown loamy sand. On the slight elevations, which are frequently found in areas of this type, the subsoil is more compact, being a red or reddish-yellow silty clay.

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In origin, topographic position and agricultural value this type is closely related to the Cahaba silt loam. Most of it lies a little higher with reference to the river channel and has more relief. As a rule, it is characteristically developed upon the low, broad swells occurring on the second bottoms of the Cahaba River.

The largest area of Cahaba fine sandy loam is located about 2 miles southwest of Centerville. The upper end of this tract, which in places is a reddish loam, marks the transition between the second and third terraces. Some of this soil is overwash material derived from the higher ground. Near the point where Affonee Creek enters the river valley there is a small area of dark reddish brown loamy sand, remarkably uniform in composition to a depth of several feet. A few very small areas of this soil occur near the Orangeburg types and are exceptionally early and productive.

This type is highly esteemed for cotton growing. It is easily cultivated, producing from one-half to 1 bale per acre. It withstands drought well, because the shallow, fine-textured soil forms a natural mulch. Even with the indifferent cultivation some of it receives, the physical condition throughout the growing season is exceptionally good.

If the humus content were increased, this type would be well adapted to corn. The suggestions regarding the adaptability of the Cahaba silt loam to alfalfa apply equally well to this soil. An excellent seed bed could be easily prepared, which would improve the chances of securing a good stand from the first seeding.

The type is well adapted to general farming. Most of it is now annually planted to cotton. It is valued at from $40 to $50 an acre, but practically all of this type is included in large plantations, seldom changing owners.

The following table gives the mechanical analyses of the soil and subsoil of the Cahaba fine sandy loam:

Mechanical analyses of Cahaba fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19058	Soil	0.3	0.2	0.5	33.2	37.8	23.1	4.7
19059	Subsoil	.0	.1	.2	21.1	24.8	31.2	22.1

HUNTINGTON FINE SAND.

The soil of the Huntington fine sand is a dark reddish-brown fine sand. In most instances it contains enough clay and silt to give the surface a loamy character, and friable clods will form if the land is plowed when wet. In some places, particularly along the river

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channel, the surface is quite loose, consisting almost entirely of fine sand.

The subsoil is an incoherent reddish-brown fine sand of variable depth. Here and there it rests upon a substratum of heavier material—a silty loam similar to the soil of the Huntington silt loam. Most of this type, however, is a sand or light fine sandy loam of unknown depth.

Small areas of this soil are found on each side of the Cahaba River. It owes its origin to the deposition of the coarse sediments brought down by this stream. When the river overflows these are dropped near the main channel or wherever the velocity of the current is checked.

In its mineralogical composition the material resembles to some extent the silt loam. It contains a good deal of fine mica and the silt and clay have much the same appearance as the fine earth of the heavier soil.

It is too light in texture to be well adapated to any but early maturing crops. Corn or cotton are liable to injury during summer droughts. It is exceptionally well suited to watermelons and cantaloupes. The narrow strips on the banks of the river are generally used for hay and pasture, on account of the uncertainty of overflows.

The results of mechanical analyses of typical samples of the soil and subsoil of this type are given in the following table:

Mechanical analyses of Huntington fine sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18737	Soil	0.0	0.8	5.2	50.6	21.1	16.2	5.8
18738	Subsoil	.2	.5	3.3	55.7	20.7	12.3	7.2

HUNTINGTON SILT LOAM.

The soil of the Huntington silt loam is a heavy silt loam, containing a small percentage of fine sand, but generally very little coarse sand and no gravel or stones. The relative proportion of clay, silt, and fine sand varies considerably, but the silt content is always high, imparting a soft and friable character to the soil, which is very apparent when it is moderately moist. On drying the surface becomes hard, but usually it is not dense. This porosity or openness in structure is characteristic of the material and is only destroyed by plowing when the soil is too wet.

The color ranges from a dull chocolate brown to a yellowish brown. It varies greatly, according to the moisture content, a wet surface being very dark in comparison with those well drained and dry. The

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organic matter content of even uncleared, well-drained areas is not usually so high as that of most alluvial soils.

The subsoil, as a rule, resembles the soil in texture and structure. The color, however, is frequently a little darker. Streaks and pockets of sandy muck and thin strata of black mud are not uncommonly found at various depths. In some places the subsoil becomes heavier as the depth increases. On most of this type, however, standing water disappears in a few days, indicating an open structure of the deep subsoil. Near the south county line water-bearing sand has been found at 20 feet. Farther up the valley gravel occurs in places at about the same depth.

The surface is uneven, often rather undulatory where low swells are separated by irregular depressions. Many partially filled channels, marking the former course of the river, occur, and swampy lagoons often separate this type from the Cahaba soils.

This is strictly an alluvial soil of recent origin. All of it is subject to overflow, with the consequent deposition of much fine material. The source of much of this sediment is the Coal Measures of the Cahaba basin.

The Cahaba River drains several hundred square miles of land lying for the most part north of the Lafayette formation. Its upper tributaries drain extensive outcrops of the principal geological formations of the southern Appalachians. The main stream is confined to a comparatively narrow gorge and has a rather high gradient. Just below Centerville the Cahaba River finds its first opportunity to break over its banks when at high flood and to deposit some of the sediment gathered along its upper course. The varied nature of this material may be indicated by naming its source. Knox dolomite, Chicamauga limestone (Trenton), and Millstone grit, with shales and sandstones of the Carboniferous group, all contribute to the quantity of yellow-brown mud which the Cahaba carries during high stages of the water.

The soil thus formed is exceedingly fertile. Undoubtedly it is well supplied with all the mineral elements and contains sufficient organic matter to meet the requirements of heavy crops of grain. It is an excellent corn soil, the yields in favorable seasons being 75 bushels per acre. Occasionally a crop is damaged or even entirely destroyed by high water in the fall, but such occurrences are not frequent. Early frosts occasionally do some injury, but corn planted as late as July 20 has matured. Oats and grass do well. Johnson grass soon takes possession of the uncultivated fields, and is particularly troublesome, since its seeds are distributed over all the land by the winter overflows.

This land commands $4 to $5 an acre rent as corn land. Its market value, although very little is for sale, is in the neighborhood

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of $50 an acre. With the exception of fences, practically none of the type has any improvements. A small proportion of the type is covered with timber, but most of it is under cultivation.

The following table gives the results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Huntington silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19072	Soil	0.0	0.2	0.2	2.9	2.7	67.0	27.2
19073	Subsoil	.0	.1	.2	10.7	8.7	51.9	28.2

WAVERLY SILT LOAM

The Waverly silt loam is an alluvial type characterized by its light color and fine texture. The soil consists chiefly of silt, having a rather high percentage of very fine sand. When dry and in good tilth it is loose and floury; when wet it has about the same color and consistency as putty, molding easily if pressed between the fingers. When thoroughly saturated, which is its usual condition during the winter months, it works up in the roads to a whitish sloppy mud that persistently adheres in a thin coat to the wheels of vehicles and the legs of horses.

There is but little textural difference between the soil and subsoil. The latter may be more compact and is mottled with streaks of yellow or very light-brownish yellow. Small iron concretions are present, but, as a rule, they are not abundant.

Near the stream channels the subsoil contains more than the average amount of fine sand. This difference in texture combined with better drainage gives the soil in such locations greater friability and a color approaching brown. This phase also occurs on small elevations and marks the transition into the Cahaba silt loam, and heavier portions of the Ocklocknee soils. Farther back from the streams and also in the central parts of some of the poorly drained second bottoms the Waverly silt loam is characteristically developed.

The organic matter content is low. The forest débris, nearly all of this type being covered with timber, usually forms a thin layer of decaying material which is scarcely mixed with the fine earth. The latter is affected only to the depth of an inch or two, and very frequently the whitish color prevails quite to the surface.

This type is found on Haysoppy, Affonee, and Blue Guttee creeks. Considerable areas occur on the second bottoms of the Cahaba River. Small ill-defined areas may be developed wherever alluvial material having poor drainage and a silty texture is found.

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The characteristic forest growth consists of beech, white oak, and swamp pine. Poplar, water oak, holly, and occasionally birch and elm occur. There is usually but little undergrowth.

The type owes its origin primarily to poor drainage. The topographic position induces periods of saturation and partial drainage which slowly alternate during the season. These variations in the moisture content and the lack of humus cause a peculiar condition or arrangement of the soil particles. They seem to have lost the property of flocculation. When wet they form a pasty mass, which upon drying firmly cements, making a crust not easily reduced to good tilth. Under cultivation this crust either breaks into hard clods or falls into a loose pulverulent dust. It is difficult to get this material into a "grainy" or friable condition suitable for the best growth of cultivated plants.

Very little of this type is under cultivation. Fields which have been cleared and drained do not give satisfactory results. Their reclamation is a problem of considerable interest, as the increasing demand for lumber will cause much of this land to be cleared in the near future. The type so closely resembles similar soils in other areas where artificial drainage has been attempted that the results can be anticipated. The movement of water through a silty soil of this character is very slow. For days after a heavy rain the soil will remain saturated within a few rods of a ditch having ample depth and fall. No better results are obtained with tile drains, as they soon become filled with fine silt.

While it is highly desirable to lower the level of the ground water, it is not advisable to attempt to do so at once by making a complete system of permanent ditches. It has been found best to have a few open mains and numerous shallow laterals. The latter may be made by "back furrowing," that is, by plowing the land in narrow strips, leaving between the strips broad and rather deep furrows parallel to the surface inclination. This comparatively inexpensive method will give fairly good surface drainage. In normal seasons small grain can be produced or tame grasses can be established, the latter being the most profitable crops for this soil. In some northern areas timothy and redtop produce heavy yields. It is highly probable if lime were applied to correct the acidity that crimson clover could be grown. Japanese clover and Bermuda grass thrive on the better drained portions of this soil.

With good surface drainage and the introduction of tame grasses the character of the soil improves. It is greatly benefited by any increase in the supply of humus, which not only changes the color but improves the texture and tends to make the soil fit for cultivated crops. The latter require aeration of the subsoil, a process dependent upon a permanent lowering of the water table. The difficulty of

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effectually accomplishing this has already been indicated. It seems that with surface drainage and the prevention of overflows by straightening the natural stream channels all except the heaviest phases of this type may be utilized for pasture, hay, or cultivated crops not too sensitive to extremes of moisture.

The following table gives the results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Waverly silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18763	Soil	0.0	0.7	0.9	2.2	4.6	64.1	27.6
18764	Subsoil	.1	.4	.6	1.0	1.8	54.3	41.7

OCKLOCKNEE FINE SANDY LOAM.

The Ocklocknee fine sandy loam is an alluvial type found along the small streams. It represents reworked Lafayette and Tuscaloosa materials which have been washed from the hillsides and accumulated along the local drainage lines. This soil usually forms the "flats" of the narrow valleys which extend back among the hills. Many of these are less than one-fourth mile in width, but several miles in length, and have numerous branches.

In most places the soil to a depth of a foot or more is of very recent deposition. Since so great a proportion of the uplands has been cleared, erosion has increased, resulting in a rapid deposition of sand and finer material over much of the former surface of the alluvium. The original character of the soil has thus been changed. It has in most instances become more sandy, and as a result of cultivation the original humus content has disappeared. The color is determined almost entirely by the mineral constituents. Where the surface materials are derived from the Orangeburg or Susquehanna soils the particles retain their coating of ferric oxide. Such phases are red or reddish brown. The older or natural surface, as it may be termed, is dark colored if some humus is present, but when this element is lacking it is some shade of gray.

In most instances the soil is a fine sandy loam to a depth of 10 to 15 inches. It is coarsest near the stream channel and in the small coves at the heads of the branches. The soil of some of the larger areas approaches a silt loam in texture, or at least includes a high percentage of fine material. The subsoil is a sandy clay or clay loam becoming heavier with depth. Not infrequently thin layers of sand occur. The lower portion is more or less mottled with gray and brown, and if the underdrainage is or has been poor iron concretions are present.

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This type has a comparatively high agricultural value. After it has been cleared and drained a few surface ditches are usually sufficient to reduce the water table to a safe level; it is easily tilled and not seriously affected by seasonal extremes. Some of it is frequently overflowed, but water does not remain on the surface long. A few places in each valley may have poor natural drainage, not easily remedied by ditches, the soil remaining cold and sour. Such areas are essentially Waverly silt loam, but it is not practicable to indicate them on the map.

Corn and cotton are the principal crops. On many farms the small area of branch-bottom land is the best soil for corn, and is continuously planted to that grain, or only occasionally changed to cotton. The original vegetable material is exhausted, and recourse is often had to commercial fertilizers and light applications of cotton-seed meal. If the humus content were increased by plowing under green crops, which could profitably be included in a rotation, this soil would need little or no other fertilization, and it is safe to say that the present average yields of these two staples would be doubled.

This soil is the favorite location for small patches of sugar-cane, which almost every farmer plants for domestic use. The yields of sirup are invariably high, but the quality is not so good as that obtained from cane grown on the light upland soils. Japan clover, Bermuda grass, Johnson grass, and crab grass make a rank growth in these bottoms.

The results of mechanical analyses of samples of this type are given in the following table:

Mechanical analyses of Ocklocknee fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18743	Soil	0.5	1.5	8.9	50.3	6.8	21.3	10.6
18744	Subsoil	.2	1.9	4.1	27.1	10.0	33.1	23.7

OCKLOCKNEE CLAY.

The Ocklocknee clay is an alluvial soil associated with the Ocklocknee fine sandy loam. It is not of such common occurrence as the latter type, since it has been formed only where the sediments consist chiefly of very fine material derived from the heaviest beds of the Tuscaloosa.

On Sandy Creek and in a few places on other small streams the soil is a clay or heavy clay loam. Along the tributaries of the above-mentioned creek, which drains "Soap Hill," the soil to a depth of

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2 to 3 inches is a reddish fine sand or sandy loam, beneath which occurs a stiff, heavy red clay. The latter is highly micaceous and becomes very soft and adhesive when wet.

Farther down the stream some of the larger areas have poor natural drainage and the clay is lighter colored. The soil is frequently a light yellowish clay loam, with varying amounts of silt and fine sand. The subsoil is a mottled clay, slippery and plastic when wet and very hard when dry. Iron concretions are not uncommon in these poorly drained spots. On slight elevations, where the drainage is better, the subsoil to a depth of several feet is a red clay. In such places there is usually more silt and fine sand in the soil than in the low areas.

Much of this soil has been cultivated many years. When new it was well supplied with humus and produced excellent crops of corn. The content of vegetable matter is now low, and the land is difficult to manage. The yields of corn and cotton are greatly affected by seasonal extremes. In many cases a short drought is as injurious as an excess of rain. This is due in a large measure to the prevailing method of cultivation.

In spring there is an excess of moisture in the soil, with perhaps a saturated condition of the subsoil. The young corn or cotton plants develop very shallow roots. After cultivation is suspended in July or August the water table has usually sunk several feet. The clayey soil, which has an inherent tendency toward compactness, becomes hard and rapidly loses moisture by evaporation. The plants are thus left rooted in comparatively dry earth. Continued shallow cultivation should be given in order to prevent the escape of moisture which rises from the lower subsoil. A boring in a field in which cotton plants are plainly suffering from lack of moisture will invariably show damp earth at less than 36 inches. Effective drainage is highly essential, and the value of this type justifies considerable outlay for such an improvement.

A few small areas of heavy yellowish clay loam on Hills Creek and Caffee Creek have been included with this type.

This soil is well adapted to oats and grass. Much of it could be profitably utilized for pasture and hay.

Owing to the variable composition of this type, no samples were taken for mechanical analyses.

ROUGH STONY LAND.

In Rough stony land have been included all those areas which as a whole are so rough and stony as to be nonarable. The extensive outcrops of the Trenton limestone near River Bend and the chert hills on the Little Cahaba River give rise to some very broken country.

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The gorges of the streams flowing through the Coal Measures are very stony and deep in places, but usually too narrow to be shown on a map of the scale used.

This type has no agricultural value, except for the scanty pasture afforded. Most of it is now forested, and the character of the timber remaining determines its market value, aside from the minerals which underlie some parts of it.

MEADOW.

Along some of the streams there are strips of alluvium so frequently overflowed or so constantly saturated that they have at present no agricultural value except for pasture. The character of the surface soil ranges from a black muck to nearly clean sand. The subsoil usually exhibits the white and mottled colors characteristic of poorly drained material.

If the stream channel were straightened and the surface cleared of brush and timber much of this land in a few years would resemble the Ocklocknee soils.

The value of some of these semiswampy areas as pasture could be increased by clearing out the dense brush and timber and encouraging the growth of grass. In similar locations elsewhere redtop (herd's-grass) has been established by merely sowing the seed broadcast without any preparation of the soil.

A phase of Meadow occurs as narrow strips of flat land on the extreme upper tributaries of Affonee and Blue Guttee creeks and consist chiefly of muck. It is a soft, black mass of decaying vegetable remains filled with the roots of trees and shrubs now growing upon the surface. Its depth ranges from a few inches to several feet. Some of the deeper parts are nearly a peat and if dry would burn.

On the larger creeks an occasional spot of mucky soil is found, but conditions have been more favorable for the accumulation of such deposits near the heads of the streams.

Similar soils farther north are used for celery and onions. Heavy crops of timothy have been secured; also corn where satisfactory drainage is established.

SUMMARY.

Bibb County is situated in the central part of Alabama, having an area of 630 square miles. The surface of much of it is hilly, and in some sections quite broken. Nearly all the drainage is tributary to the Cahaba River, which has a southwesterly course through the center of the county. The lower half of the stream flows through a valley from 2 to 3 miles wide. The tributary streams in the southern half of the county have more or less bottom land, but those in the northern part, as well as the river itself, have very little alluvium.

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Physiographically the northeastern part is the extreme southern end of the Appalachian Mountain system, the remainder of the county being essentially a part of the Coastal Plain.

The settlement of this county began about one hundred years ago. The majority of the early immigrants came from the Carolinas and from Tennessee. The present population of the southern and western parts is almost entirely rural, consisting for the most part of American-born citizens. In the northeastern part there are comparatively few farmers. Many of the residents in this section are foreigners or of foreign descent, and are employed in the coal mines.

Blocton, the business center of the mining industry, is the largest town. Centerville, located at the head of the Cahaba Valley, is the county seat.

Transportation facilities are good. The Mobile and Ohio Railroad crosses the southern part of the county, the Southern Railway the eastern, and the Louisville and Nashville and the Alabama Great Southern roads serve the northern part of the area.

The main county roads are being rapidly improved. Telephone lines and the rural delivery of mails extend to all the well-settled portions of the county.

The climate admits of the production of a wide range of crops. The growing season extends from the middle of March to the first of November. The rainfall of about 50 inches is usually well distributed.

Since the early settlement of the county cotton and corn have been the principal agricultural products. At present cotton is the money crop. A considerable acreage of corn is grown, but the average yield is 12 to 13 bushels per acre; usually it does not meet the requirements for home use.

Cowpeas, oats, sorghum, and other forage crops are not extensively grown, and not very much attention is given to stock raising. The local demand for meats, dairy and poultry products, and feed stuffs, such as hay and grain, is in excess of the production.

A limited amount of fruit and truck is produced. Although conditions are favorable for these industries, they have never been attempted on a commercial scale.

The largest plantations are located in the Cahaba Valley. Most of the cotton produced on them is grown by negro tenants.

The smaller farms are usually occupied by the owners, who rent part of their tillable land to negroes and also hire hands. The wages of the latter range from $10 to $15 a month.

Twenty-six types of soil were mapped in this area. They may be divided into three general divisions—the residual soils of the northeastern part of the area, the red upland types in the western and southern sections which are derived from the Tuscaloosa and Lafayette formations, and the alluvial types.

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The Dekalb fine sandy loam has an extensive development in the northeastern part of the county. It is derived directly from sandstones of the Coal Measures.

Two types of agricultural value are derived from the Trenton limestones—the Decatur loam and clay loam.

The Clarksville stony loam is a type of low agricultural value and is derived from a very cherty limestone. It is frequently associated with Rough stony land and often called "Flint Hills."

The Orangeburg series includes two members. The fine sandy loam and the gravelly sandy loam occupy extensive areas in the uplands and include some farming lands well adapted to cotton, cowpeas, oats, and a great variety of minor crops.

The Greenville fine sandy loam is a highly valuable type for general farming.

The Guin soils are closely related in origin to the Orangeburg soils. They are lighter colored, have sandier subsoils, and are not so well adapted to the production of cotton and corn.

The Susquehanna soils include a gravelly loam which is found principally in the western and southern parts of the county. Most of it is of low agricultural value and should remain forested. The fine sandy loam has a very heavy subsoil, and in general is not as easily tilled or as productive as the Orangeburg fine sandy loam, which, in many places, it closely resembles.

The Kalmia fine sandy loam is a valuable type for general farming. It is related to the Orangeburg soils, and is usually found on the lower slopes of the hills and in some of the recent bottoms.

The Ocklocknee soils are found along the small streams. They represent the accumulation of sand and clay washed from the hills of Tuscaloosa and Lafayette material. Their present agricultural value depends largely upon the drainage.

The Huntington soils are the overflow lands of the Cahaba River. They, as well as the Cahaba soils, are composed chiefly of alluvial materials derived from the various formations found in the Cahaba coal fields. They are very fertile and constitute some of the most valuable farming land in the county.

The light colored and poorly drained soils along the creeks and in the lower Cahaba Valley have been included in the Waverly series. Owing to their poor drainage they have a rather low agricultural value.

A few types of soil, members of the Norfolk and Montevallo series, occur in limited areas and form an unimportant part of the soil resources of the county.

The Rough stony land, a nonagricultural type, and Meadow are of little importance in the county.

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SOIL SURVEY OF ETOWAH COUNTY, ALABAMA.

By W. S. LYMAN, of the U. S. Department of Agriculture, and C. S. WALDROP, of the Alabama Department of Agriculture and Industries.

DESCRIPTION OF THE AREA.

Etowah County, with an area of 346,880 acres, or 542 square miles, is situated in the northeastern part of Alabama in what is popularly known as the mineral section of the State. It is bounded on the north by Dekalb County, on the east by Cherokee, on the south by St. Clair and Calhoun, on the west by Blount, and on the northwest by Marshall.

Included in the county are the broad, undulating valley of the Coosa River, the level or gently rolling plateaus of Sand and Lookout mountains, and a mountainous region characterized by a succession of ridges alternating with narrow limestone valleys. The character and position of these mountains, plateaus, and valleys are closely connected with the character and structure of the underlying rocks or geological formations. Some of these formations occur in rather narrow bands and all run in a general northeast-southwest direction.

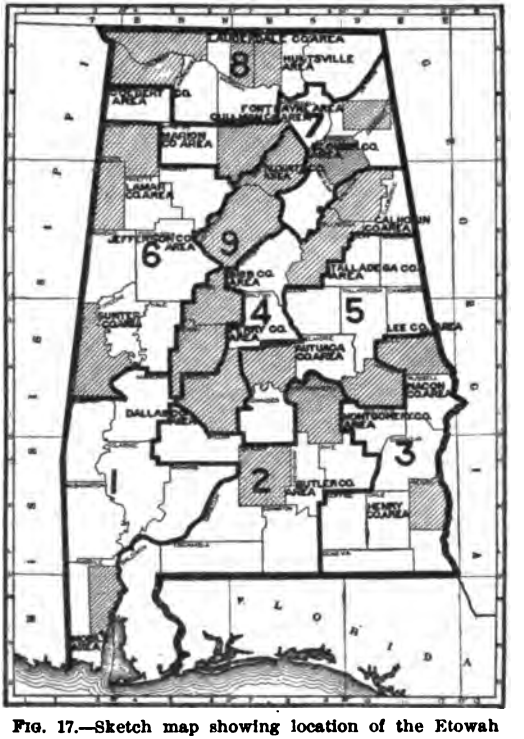

FIG. 17.—Sketch map showing location of the Etowah County area, Alabama.

In the northwest part of the county the broad top of Sand Mountain forms a plateau having an elevation of from 1,100 to 1,200 feet above sea level, while in the northeast part, extending in a northeast-southwest direction to about the center of the county, is Lookout

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Mountain, on which is another smaller plateau 3 to 5 miles wide. These plateaus are quite similar in many respects, each being higher on the edges, sloping gradually toward a trough in the center, and bounded on the edges by bold escarpments 600 to 800 feet high. On Sand Mountain, in particular, are many large, quite level, and densely wooded areas. The continuity of this plateau is broken on the edges in several places by stream action, deep gorges being cut back from the escarpment for some distance.

From Attalla northward the valley between Sand and Lookout mountains is separated into two distinct valleys by an elongated ridge which in places is almost as high as the mountains on either side. The valley, about 5 miles wide between these two mountains, is hilly, due to the character of the underlying limestone. This same belt of hilly country extends southwest of Attalla to the county line, but is bounded on the south by a fault line separating it from the broad, undulating Coosa River Valley. Extending east from Attalla, cutting around the end of Lookout Mountain and Shinbone Ridge, which lies just southeast of Lookout Mountain, this fault line runs northeast from Gadsden to the county line, here also being the boundary of the Coosa River Valley. The southern border of the Coosa River Valley, which is 5 to 7 miles wide, is formed by Calvin Mountain, the watershed of which is a part of the south county line.

The elevation of Etowah County varies from 1,500 feet at a point on Lookout Mountain northeast of Gadsden to a little less than 500 feet at a point where the Coosa River breaks through Calvin Mountain.

The main drainage of the county is toward the southwest to the Gulf and is effected through the Coosa River and its tributaries, the most important of which are Big Wills, Little Wills, Clear, and Little Canoe creeks. Locust Fork of Black Warrior River and its tributaries drain the northwest corner of the county. Only a small area northwest of Mountainboro lies in the Tennessee River drainage basin, this section being drained by Short Creek, which empties directly into the Tennessee River 12 to 15 miles to the north.

The population of Etowah County are mainly the descendants of those who came from Tennessee, Georgia, the Carolinas, and Virginia at an early date, settling on the rich valley limestone soils and on some of the alluvial soils of the Coosa River Valley. Sand Mountain was settled largely by Georgians. The lands in this section of the State were then considered by Alabamians too poor to cultivate, but now their productiveness is well recognized. Within the past few years a small number of Germans have settled in the Sand Mountain section. Some immigrants have located in the towns and found employment at the cotton mills, smelters, or steel plants, and others in the surrounding iron and coal mines.

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Except in local sections, the county has always been rather thinly settled. Settlement is most rapid just now on the limestone and alluvial soils around Gadsden and Attalla and on the fertile soils on Sand Mountain. During the past two or three years farm property has been changing hands more rapidly. Pike roads are being built by convict labor, and already several of the main roads have thus been improved.

Gadsden, the county seat and largest town, has a population of about 8,000. Alabama City, a manufacturing town 2 miles west of Gadsden, has a population of about 2,500; and Attalla, with a population of about 2,000 and 3 miles still farther west, is another important town. These three towns are connected by an interurban car line. Iron furnaces are located at all three places. At Alabama City are a large cotton mill and a steel plant, and at Gadsden there are several factories employing several hundred men. Altoona, in the extreme western part of the county, is a coal-mining town and affords a small market for that section.

Etowah County is well supplied with railroads, five lines entering one or more of the three towns in the center of the county. These roads furnish excellent transportation facilities to large outside markets, Atlanta, Chattanooga, and Birmingham all being less than three hours distant. The Coosa River furnishes water transportation as far as Rome, Ga., and to the Shoals, about 20 miles below Gadsden.

CLIMATE.

The climate of Etowah County is comparatively equable and mild. The summers are long and pleasant and the winters are short and mild. There are occasional "cold snaps," though the mercury seldom falls below zero. Light snows of short duration occur nearly every winter. Besides the crops grown, the climatic conditions are favorable for many other crops not yet introduced. The so-called winter crops suitable for stock raising may be safely relied upon through the winter.

The average annual precipitation, which is about 52 inches, is sufficient for all the crops grown. Occasional droughts in middle and late summer would have little effect on crops if the farmers gave more attention to tilling their soils in such a way as to conserve the moisture. During the winter months the rains are heavier and of longer duration, a fact which suggests the advisability of growing winter crops so as to prevent washing and gullying on exposed hillsides and slopes.

The early warm days of spring and the erratic occurrence of killing frosts cause the fruit crop to be uncertain unless care has been used in selecting orchard sites.

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The average dates of the last killing frost in the spring and of the first in the fall are about April 6 and October 22, respectively. This gives an average growing season for tender vegetation of about six and one-half months.

The mean annual temperature is about 61° F. The mercury seldom goes above 100° F. in summer or below 5° in winter.

The following table, compiled from records of Weather Bureau station at Gadsden, gives the normal monthly and annual temperature and precipitation:

Normal monthly and annual temperature and precipitation.

Month.	Gadsden.		Month.	Gadsden.	
	Temperature.	Precipitation.		Temperature.	Precipitation.
	°F.	Inches.		°F.	Inches.
January	41.4	5.55	August	78.7	4.33
February	42.3	5.47	September	73.9	3.16
March	51.9	6.39	October	61.6	2.67
April	59.6	4.18	November	51.0	3.39
May	73.9	3.63	December	44.2	4.94
June	76.6	4.30			
July	79.5	4.05	Year	61.2	52.06

AGRICULTURE.

With the exception of cotton, which was shipped to a small extent, all the crops grown by the early settlers were consumed at home. Cotton and corn always have been the main crops, with a small acreage devoted to wheat, oats, sorghum, peas, peanuts, hay, vegetables, and tobacco. Cattle raising is also being carried on in a limited way. As the population increased and transportation facilities became better, a type of agriculture similar to that in practice at the present time was gradually evolved.

As in other mountainous sections where land is cheap and easily obtained, the farmers have been slow to adopt improved methods and the use of labor-saving machinery. In some instances steep hillsides and Rough stony land are being cultivated where only the simplest kind of implements can be used, and those who are farming under such unfavorable circumstances are barely making a living. Even on the better soils many farmers are making little headway, largely because of the use of old and crude machinery.

More attention needs to be given to the maintenance of the productivity of the soil through a proper system of crop rotation and by practicing thorough up-to-date cultural methods. Many fields have been planted to either cotton or corn for a number of years, thus materially reducing the yields. The plowing is generally too

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shallow and the fields and rows are usually laid out without regard to the lay of the land.

The present backward stage of agricultural development is due in no slight degree to the growing importance of the iron industries of the county.

Cotton is the all important crop. According to the census of 1900, the acreage given to cotton was, approximately, 30,000, producing on an average 1 bale to about 2½ acres. At present cotton is grown much more extensively, though the yields per acre have probably remained about the same. It is grown on most every type of soil regardless of topography or productivity. The best cotton lands are the fine sandy loams, loams, silt loams, and some of the clay loams. On these the yields vary from one-third to 1 bale or more per acre. Cotton is very susceptible to methods of good tillage, which implies not only deep preparation and thorough subsequent cultivation, but a good system of rotation and manuring to keep the soil in a high state of productivity. A few farmers realize the importance of these methods, but the production of a vast majority of the farms could be secured on half the acreage planted.

Corn, the next important crop, is grown only for home consumption. Like cotton, it is grown on nearly all the soils, but does best on the rich alluvial loams, silt loams, and fine sandy loams. The yields range anywhere from 5 to 50 bushels per acre, and average, according to the last census, about 14 bushels per acre. Any of the soils of the area are capable of producing a higher average than this, if good cultural methods are followed. The fact that most farmers neglect their corn crop in favor of cotton partially explains the low yield.

Many other crops are grown in a limited way, among which may be mentioned oats, wheat, sorghum, peas, peanuts, hay, and such vegetables for home use and the local market as Irish potatoes and sweet potatoes, cabbage, collards, beans, onions, etc. The sandy soils are best for garden vegetables, except crops like cabbage, collards, etc., which thrive best on the heavier richer soils. Peas and peanuts are valuable crops, not only because of their feeding value, especially for hogs, but for their beneficial effect upon the soil. There is need of more attention along the lines of dairying, stock raising, and forage crops; also truck and tobacco. The first three lines of farming may be best done on the heavier soils. Tobacco will probably do best on some of the mountainous Dekalb sandy and silty types and Clarksville stony loam.

The fruit industry has been developed by a few on a commercial scale, but most orchards show the lack of proper attention. Several large peach orchards are located in the vicinity of Gadsden and Attalla. Some apple orchards have been set out, and where well

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cared for are in a thrifty condition. The Clarksville stony loam on northern slopes is an excellent soil for these fruits. The Dekalb stony silt loam is also very good for apples and the more sandy phase for peaches.

Some system of crop rotation is necessary on all the soils in order to obtain good yields. When a rotation is practiced the soils suffer less from erosion and more profitable yields are continuously obtained without the aid of commercial fertilizers. A rotation of peas, or some other leguminous crop, with corn and cotton has been practiced by the more successful farmers. This practice is to be commended. The sowing of peas, vetch, and other leguminous crops between corn and cotton rows after the last cultivation is another cheap and easy way of keeping the soil in a good productive state. Usually the crop is cut for forage, returning only the roots to the soil, though a few plow under the whole crop. In most cases the latter method is preferred, but when a heavy crop is thus turned under liming may be necessary, not only to aid in the proper decay of organic matter, but to correct any acidity which may arise.

Commercial fertilizers are used generally throughout the county. They are applied, as a rule, merely to increase the yields and without any thought as to the requirements of the soil or its permanent upbuilding. According to the Twelfth Census $39,120 was expended in 1899 for fertilizers by the farmers of this county. The amount spent during the past year would no doubt show a considerable increase.

In the growing of cotton and corn and most other crops that are intertilled, ridge cultivation is generally practiced. Often the fields are left level until the last cultivation, when the soil is ridged up in the rows and the crop "laid by," as it is called. The ridge method of "laying by" crops should be abandoned, as not only the yields are materially reduced by loss in soil moisture, but some of the roots, which lie close to the surface in midsummer, are broken off, thus diminishing the crop's feeding capacity. Level cultivation, except in a few poorly drained areas and where the slopes are not too steep, gives the best results, as the soil retains a larger quantity of moisture and crops suffer less from the effect of summer droughts. Little attention is given to the prevention of soil washing and the formation of gullies. Deeper plowing in preparing the land, where the slopes are not too steep, thus allowing more of the rainfall to be absorbed, will help to prevent washing. In the hilly and mountainous sections terracing and contour cultivation should be practiced with the same end in view. Deeper plowing would not only give the soil greater water-holding capacity, but would also greatly improve the seed bed, thereby allowing young plants to obtain a stronger foothold and to penetrate the subsoil more deeply for food and moisture.

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The labor conditions in the area are not of the best. The iron and kindred industries of the county attract considerable labor from the farm because of higher wages paid and employment given for the full year. Much of the hired labor is done by negroes, though considerable work is done by the white farmers and their families, especially in the northern part of the county. During the busy season women and children all work in the fields.

Most of the farms are cultivated by the owners, particularly in the mountainous section, though some are tilled by tenants. Some of the tenants are negroes, but the majority are white. Very few farms are rented for cash, the more common practice being to rent on shares. The owner receives one-third of the corn and one-fourth of the cotton, if the renter furnishes tools and work stock, but in case these are furnished by the owner he receives one-half the crops.

There is considerable variation in the size of farms throughout the county. According to the Census of 1900 the average size is 86.1 acres. The value of farm land varies from $3 to $40 an acre, according to the kind of soil and the location of the farm.

That the farmers of the area, as a class, are not in a more prosperous condition is not attributable to the broken topography and nonproductiveness of the land. The tendency to grow all the cotton possible and to depend on it as the only money crop does not assure the best results for the farmer. In most cases it is decidedly unprofitable to grow cotton continuously on the same land, the result of which must be diminishing yields and the gradual impoverishing of the soil. The adaptability of soils to crops should be recognized, and those soils better suited to other crops than cotton should be devoted to such crops. In fact, on land best adapted to cotton a well-balanced crop rotation should be practiced, so as to maintain productivity and good yields. The slopes, which have a strong tendency to wash or gully, can be better left in grass or forested. Some of the heavier soils afford an excellent opportunity for stock raising, dairying, and hay farming, all promising industries of the county. Stock raising and dairying, no doubt, would be found remunerative on practically all soils of the area, as there are good home markets and larger ones near by. In the mountainous section are found soils well adapted to fruit, especially peaches and apples, and to tobacco as well.

The net returns to farmers throughout the county could be materially increased by practicing thorough tillage, rotation of crops, and by growing a greater variety of crops adapted to their soils.

SOILS.

In its physiographic and geological relations, Etowah County forms a part of the great Appalachian province extending from central Alabama to northeastern Pennsylvania. The two divisions

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represented in the county are the Appalachian valley and the western division of the Appalachian province, as it is called. The former embraces the Coosa Valley and the latter the mountainous portion of the county. The rocks exposed are all of sedimentary origin, belonging to the Paleozoic age, and consist of crumbled and folded shales, limestones, conglomerates, and sandstones varying in degrees of purity and hardness. They were deposited as ocean sediments during the different eras from Cambrian to Carboniferous and eventually consolidated and afterward elevated to highlands. By folding and subsequent erosion, the soft rocks not being able to resist erosion so well as the harder sandstone cappings, the county assumed the main features of topography already described.

The constituent strata of Etowah County contain, lying in close proximity, large and workable quantities of iron, coal, and limestone, a very desirable and necessary combination for the cheap production of iron.

All of the soils of the county, except alluvial and colluvial strips which represent a mixture of material from several formations, are derived directly from the decay and disintegration of the rocks on which they lie.

In the mountainous part of the county are found five members of the Dekalb series, derived from sandstones and shales, constituting practically the entire area of this region. The silt loam, fine sandy loam, and sandy loam members occupy the rolling tablelands. These are the farming lands in this district, all being well drained and easy to cultivate. While it is true that they are not naturally very productive, they are readily susceptible to improvement by fertilization and good methods of cultivation, and when so treated produce excellent yields of staple crops, particularly cotton, as well as some of the truck crops. The rougher areas give rise to a stony silt loam or to Rough stony land.

The narrow mountain valleys present a variety of limestone soils, due to the composition and structure of the underlying rocks. In point of most importance are the Hagerstown soils, the loam member of which is the only one extensively developed. Derived from the cherty limestones are large areas of Clarksville stony loam. Other soils also occur, varying in degrees of color and texture and amount of rock fragments on the surface.

Located in the Coosa Valley is the oldest formation in the county, a clay shale from which is derived a stiff, waxy, impervious clay locally known as "flatwoods land." In this valley, skirting the Coosa River and overlying material similar to "flatwoods land," are also large areas of alluvial soils, deposited at a time when the stream bed stood at a higher level. Along many of the smaller streams in all parts of the county are found narrow strips of alluvial soil.

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In all, Etowah County presents an area of diversity in soils and conditions sufficient to meet the demands of the most diversified farming. Twenty soil types were mapped, varying from heavy clays to sandy loams. While some of these soils show a low agricultural value after their virgin productiveness has been reduced by careless methods of tillage and cropping, all the types of soil, owing to their inherent qualities, if better handled and cropped according to adaptability, could be brought to much account in the agricultural development of the county.

The names and extent of the different types of soil are given in the following table:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Conasauga clay	52,160	15.0	Meadow	7,296	2.1
Dekalb silt loam	50,176	14.5	Huntington sandy loam	5,888	1.7
Clarksville stony loam	47,040	13.6	Locust silt loam	4,992	1.4
Dekalb fine sandy loam	40,384	11.6	Dekalb shale loam	4,928	1.4
Holston fine sandy loam	36,416	10.5	Holston gravelly sandy loam	2,944	.8
Dekalb stony silt loam	26,304	7.6	Holston silt loam	2,368	.7
Hagerstown loam	19,328	5.6	Hagerstown stony clay	1,536	.5
Huntington silt loam	14,528	4.2	Hanceville loam	1,024	.3
Dekalb sandy loam	11,776	3.4	Decatur clay loam	384	.1
Clarksville gravelly loam	9,984	2.9			
Rough stony land	7,424	2.1	Total	346,880	.....

DEKALB SILT LOAM.

The surface soil of the Dekalb silt loam, to a depth of 8 to 18 inches, consists of a gray to yellowish-gray mellow silt loam having a small sand content of the finer grades. The line between the soil and subsoil is nowhere sharply drawn. The soil grades into a reddish-yellow or yellow silty clay subsoil, not plastic or tenacious, but having a slightly greasy feel. Broken masses of rock fragments are sometimes found within 3 feet, and nearly everywhere on the surface and throughout both soil and subsoil are scattering fragments of sandstone and shale.

The Dekalb silt loam occurs in large areas on Sand and Lookout mountains, occupying for the most part rolling table-lands. On Lookout Mountain, lying about 75 feet above the main body of the type, small areas are found following the crests of ridges which border the escarpment.

The topography of the type, as a whole, is rolling, with a more broken surface near the streams, being the more rolling on Lookout Mountain and in places rather hilly. The natural drainage is good. A tendency to wash is noticeable on the steeper slopes; therefore they should not be planted to cultivated crops.

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The soil is of residual origin, derived almost entirely from the broken-down Walden formation, which consists of fine-grained sandstone and sandy shale.

The Dekalb silt loam is one of the extensive and widely cultivated soils on Sand Mountain, while on Lookout Mountain only the more level portions which have been cleared of the native hardwood timber and scattering pine are tilled.

The principal crops grown are cotton and corn, with scattering small fields of oats, wheat, and grasses. Wheat planted in October and harvested in June produces a good quality of straw, but the yields of grain are light, averaging about 8 bushels per acre. Grasses do well and should be more widely grown. Cotton produces from one-fourth to five-eighths of a bale, and corn from 5 to 40 bushels per acre, depending upon the state of cultivation.

As on all the soils of the area, a small acreage is given to cowpeas and peanuts, and also to sorghum for both forage and sirup.

The Dekalb silt loam is best adapted to grasses and general farming purposes. It ranges in price from $10 to $25 an acre.

The results of mechanical analyses of the soil and subsoil of this type are given in the following table:

Mechanical analyses of Dekalb silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19857	Soil	0.3	1.0	3.5	14.8	12.9	56.4	11.3
19858	Subsoil	.0	1.1	3.1	10.9	12.7	46.9	25.3

DEKALB SHALE LOAM.

The soil of the Dekalb shale loam consists of about 8 inches of a yellowish-gray or gray heavy silt loam. In structure it is rather compact and when rubbed between the fingers has a greasy feel. By reason of the compact and greasy nature of this soil much of the rainfall, particularly when the soil is dry, runs off quickly in surface drainage. Large quantities of shale fragments are found upon the surface and in the soil. The subsoil to a depth of 24 to 30 inches is a yellow to reddish-yellow silty clay resting upon a broken mass of shale and shaly sandstone from which it is derived.

The surface features range from rolling to slightly hilly, but are rarely so rough that the soil can not be cultivated. Between the ridges and knolls are numerous intermittent streams affording excellent drainage.

The Dekalb shale loam is of limited extent, only two areas being mapped, one in the southeast corner and the other just northeast of Howelton, in the west-central part of the county.

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Only a few small fields of this type are being cultivated, and the yields of cotton and corn secured are scarcely enough to meet the cost of producing the crop. The best use of this type is for forestry or as pasture.

The results of mechanical analyses of soil and subsoil are given in the following table:

Mechanical analyses of Dekalb shale loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19853	Soil	3.7	9.1	2.8	4.9	8.3	54.3	17.2
19854	Subsoil	2.9	7.1	2.5	4.4	4.0	50.3	29.1

DEKALB SANDY LOAM.

The soil of the Dekalb sandy loam is a yellowish-gray to yellowish-brown medium to fine sandy loam, with a depth varying from 10 to 15 inches. The subsoil is a yellowish-brown medium to fine sandy loam heavier than the soil. Bed rock often occurs within 3 feet and occasionally appears upon the surface.

Only four areas of the Dekalb sandy loam are found in the county. The main bodies occur along the slopes on either side of the plateau on Lookout Mountain and smaller areas southeast of Attalla and south of Altoona. The surface in places is somewhat hilly, but for the most part consists of easy slopes varying from rather level to gently rolling in character. The type is naturally well drained by small and mostly intermittent streams and as a rule is not droughty, except where the underlying rock is close to the surface.

The type is derived from the weathering of Lookout sandstone, a gray to brown medium to fine grained stone.

The Dekalb sandy loam is easily cultivated and responds readily to good methods of cultivation and to fertilization. Cotton yields from one-third to five-eighths of a bale per acre, and when well cultivated better results are secured. The yield of corn varies from 5 to 40 bushels. Some cowpeas are grown, and very good yields of both Irish and sweet potatoes are secured. This type presents a good opportunity for fruit raising, particularly the northern slopes, owing to the greater immunity from late killing frosts in the spring. Peaches, plums, and cherries do well. Apples are readily grown and the fruit is well flavored and of large size. This is perhaps the best truck soil found in the area, though not well adapted to cabbage or cauliflower, which require a heavier soil. Melons have been grown with excellent success. Tobacco has been grown for home use to some extent, and it is believed this crop would prove a remu-

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nerative one to the farmer. The Dekalb sandy loam can be bought for $3 to $15 an acre.

The results of mechanical analyses of samples of the Dekalb sandy loam are shown in the following table:

Mechanical analyses of Dekalb sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
20278	Soil	0.4	7.4	21.5	31.8	7.1	24.1	7.9
20279	Subsoil	.9	8.4	18.0	26.5	5.0	24.6	16.8

DEKALB STONY SILT LOAM.

The Dekalb stony silt loam is a mountain-side type consisting of a yellowish-gray or brown fine sandy loam or silt loam about 10 inches in depth, usually underlain by a lighter yellowish-brown or gray fine sandy loam or silt loam grading at from 2 to 3 feet into a clay. Areas where the soil is found to be silty are almost always bordered by the Dekalb silt loam and are more productive. Fragments of sandstone, some of which are very large, are strewn over the surface and throughout the soil mass. Occasionally bed rock is found within 3 feet of the surface. Large rock outcrops or cliffs frequently appear throughout areas embraced by this type of soil and are indicated on the map by symbols.

The Dekalb stony silt loam owes its origin to the weathering and breaking down of the underlying light or brownish-gray fine-grained sandstone.

Occurring on the sides of plateaus and mountain sides leading down into the limestone valleys, as does this soil, and owing to the comparatively low prices at which other land is sold, it is not considered profitable to use this soil for the production of staple crops. It is best for it to remain forested to the native hardwood and scattering pine timber or else used for the production of apples or peaches. The sandy phase is best suited to peaches. A few small fields are cultivated to corn, moderate yields being secured.

The results of mechanical analyses of this type of soil are given in the following table:

Mechanical analyses of Dekalb stony silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
20280	Soil	1.1	2.3	1.1	2.4	5.4	74.8	13.2
20281	Subsoil	1.1	1.8	.9	2.2	6.5	71.2	16.4

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DEKALB FINE SANDY LOAM.

The soil of the Dekalb fine sandy loam, to a depth of 8 to 12 inches, is a yellowish-gray to yellowish-brown fine sandy loam containing some silt. This material is underlain by a yellow to reddish-yellow fine sandy loam heavier than the soil and often grading at about 3 feet into a silty clay of a more decided yellow color. In proximity to streams and depressions a few small scattering areas of a more sandy phase of this type occur.

The fine-grained sandstone from which this type is derived is sometimes encountered within 3 feet of the surface, and outcroppings occasionally occur.

The type for the most part occurs in the northwest part of the county occupying the table-lands on Sand Mountain. Another small body is found on Lookout Mountain north of Gadsden, and three scattering areas occur along the south county line bordering Calhoun County.

In surface features the Dekalb fine sandy loam varies from rather level to gently rolling, with a few steep slopes near some of the larger streams. The topography of the type for the most part admits of easy drainage, but in a few instances during wet seasons artificial drainage is desirable and this may be easily secured by means of open ditches nearby natural drainage channels. The type is intersected by many small streams which are mostly intermittent.

A large part of the Dekalb fine sandy loam is under cultivation. Owing to its texture it is easily worked and readily absorbs the rainfall. While it is not naturally a strong, fertile soil it is very susceptible to good methods of tillage and to fertilization, particularly the addition of vegetable matter. It is perhaps adapted to a wider variety of crops than any other soil type in the area. Cotton and corn are the only crops extensively grown. A small acreage is given to potatoes, oats, peas, peaches, apples, and a few garden vegetables. Yields of cotton vary from one-half to 1 bale or more and of corn from 10 to 45 bushels or more per acre, the yields depending on treatment given these crops. Sweet potatoes do very well, as do Irish potatoes. In adaptation to truck crops this type is about equal to the Dekalb sandy loam. Melons do very well. Cabbage and kindred crops should not be grown commercially on this soil. On northern exposures peaches do well and the apples are of large size and well flavored. It is probable that tobacco could be successfully grown on this soil. Land of this type of soil varies in value from $10 to $30 an acre.

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The results of mechanical analyses of soil and subsoil of the Dekalb fine sandy loam are given in the following table:

Mechanical analyses of Dekalb fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19855	Soil	0.0	0.9	7.8	34.2	7.4	41.9	8.0
19856	Subsoil	.0	.8	7.5	33.6	7.4	38.6	12.3

CLARKSVILLE STONY LOAM.

The surface soil of the Clarksville stony loam to a depth of 10 to 14 inches consists of a gray to yellowish-gray or light-brown silty loam to silt loam. Underlying this material is a yellow or reddish-yellow heavy silt loam which quickly grades into a silty clay, all containing a small per cent of sand, mostly of the finer grades. Scattered on the surface and throughout the soil mass are found from 15 to 50 per cent of angular chert and siliceous limestone fragments varying in size up to 10 inches or more in diameter. This type is locally known as "gravelly land."

The type occupies a very broken country consisting of hills and ridges, with intervening narrow valleys. It occurs in bands of varying widths, the widest being between 3 and 4 miles, and all running in a northeast-southwest direction. The largest bodies are found north and west of Attalla and near the south county line bordering Calhoun County.

The Clarksville stony loam is of residual origin and is the result of the weathering and breaking down of Knox dolomite formation, which is a limestone containing a large percentage of difficultly soluble quartz in the form of chert. The more soluble portion of this type was gradually dissolved, leached out of the soil, and carried away, leaving behind the hard flinty material.

Owing to its topographic position and stony nature little of this soil is under cultivation, and at present it is very largely covered with a growth of oak timber, some pine, chestnut, and hickory. It is best, perhaps, that much of it should remain forested. When cleared and cultivated the tendency to wash is noticeable. While the soil is usually of a gray color it becomes, when cultivated for some time, so depleted of organic matter as to be almost white. Usually only the more gentle slopes, where rock fragments are smaller and less numerous, are being tilled.

Staple crops do moderately well on newly cleared fields, but unless considerable care is taken to keep up the fertility of the soil yields scarcely pay for the cost of production. In favorable locations

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peaches and apples do well, the fruit being of good flavor and excellent keeping qualities. On the less stony areas it is believed tobacco could be successfully produced.

The Clarksville stony loam can be bought for $3 to $10 an acre.

The results of mechanical analyses of soil and subsoil are given in the following table:

Mechanical analyses of Clarksville stony loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19833	Soil	4.5	10.7	5.2	7.4	2.4	54.3	15.3
19834	Subsoil	5.1	6.7	3.4	5.2	2.2	51.0	26.5

CLARKSVILLE GRAVELLY LOAM.

The soil of the Clarksville gravelly loam to a depth of about 12 inches is a gray to yellowish-gray silt loam containing a small amount of fine sand. The subsoil is a grayish to reddish-yellow heavy silt loam quickly grading into a silty clay which is also slightly sandy. From 10 to 25 per cent of small angular chert gravel is found on the surface and smaller quantities appear throughout the soil mass.

This type is nearly always found lying adjacent to areas of Clarksville stony loam. In some respects these two soils are closely related, while in others they are widely separated. They are much the same in texture and are identical in derivation; except in a few instances the material of the gravelly loam is colluvial, having been washed down from higher lying areas of Clarksville stony loam. There is a wide difference in topography, the gravelly loam being undulating to gently rolling and therefore more easily cultivated.

Much of this soil is under cultivation. Cotton and corn are the only crops grown and usually fair yields are secured. This type of soil is best suited to general farming and stock raising. Prices paid for land of this character range from $3 to $15 an acre.

The results of mechanical analyses of soil and subsoil are given in the following table:

Mechanical analyses of Clarksville gravelly loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19837	Soil	1.7	5.5	6.1	10.6	2.6	59.3	14.1
19838	Subsoil	1.1	4.3	5.5	9.6	2.5	54.9	21.9

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HOLSTON FINE SANDY LOAM.

The surface soil of the Holston fine sandy loam is composed of about 12 inches of light or yellowish-gray fine sandy loam containing a considerable amount of silt. The subsoil is a brownish-yellow to yellowish-brown fine sandy loam to silty loam. At depths varying from 4 to 10 feet material is encountered which is similar to that of Conasauga clay.

The Holston fine sandy loam, locally known as "piney-woods land," is confined to the valley of the Coosa River and is one of the most extensively developed soils found in this region. Its position is that of a high second bottom and is never subject to overflow. The topography of the type is undulating and the drainage adequate. It is an alluvial soil, the material having been brought down by the river and deposited in times of overflow or when the stream bed stood at a higher level.

The soil is easy to cultivate, but is somewhat deficient in organic matter. It responds readily to good tillage and fertilization, however, and the addition of barnyard manure or other organic matter proves highly beneficial.

Practically all of this soil is under cultivation and is used principally in the production of cotton, with a small acreage to corn. It is well adapted to cotton, but only fairly well to corn. Several of the garden vegetables are grown for local markets and all do well, especially potatoes. Prices paid for this soil vary from $15 to $35 an acre.

The results of mechanical analyses of samples of this soil type are given in the following table:

Mechanical analyses of Holston fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19847	Soil	0.2	1.0	2.5	28.1	14.1	46.8	7.4
19848	Subsoil	.0	.5	2.1	24.4	13.3	45.3	14.3

HOLSTON GRAVELLY SANDY LOAM.

The soil of the Holston gravelly sandy loam consists of about 10 inches of light-gray fine sandy loam containing a considerable amount of silt and from 15 to 40 per cent of fine waterworn gravel. The subsoil is a grayish-yellow to yellow fine sandy loam heavier than the soil and grading at 3 to 5 feet into a yellow heavy silt loam or silty clay. Waterworn gravel appears in the subsoil in small quantities.

Small areas of this soil are found here and there throughout the Coosa River Valley. It occurs as narrow ridges or mounds within

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the boundaries of other soil types found on second bottom, or along the slopes of bluffs between the Holston fine sandy loam and Huntington silt loam.

The type is sometimes cultivated to cotton, and fair yields are secured. The soil lacks organic matter, hence applications of barnyard manure and the growing of cowpeas and kindred crops are highly beneficial. Owing to its somewhat droughty condition, this soil requires careful methods of cultivation to conserve soil moisture.

The results of mechanical analyses of soil and subsoil are shown in the following table:

Mechanical analyses of Holston gravelly sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19849	Soil	4.1	11.0	4.9	10.8	7.7	51.8	9.7
19850	Subsoil	3.2	8.4	4.2	9.9	8.3	48.6	17.5

HOLSTON SILT LOAM.

The Holston silt loam is a light to yellowish-gray floury silt loam, underlain by a heavy silt loam to silty clay. The subsoil is often mottled and a small number of iron concretions are present, underlying which at depths varying from 4 to 15 feet appears material similar to that of Conasauga clay.

The Holston silt loam is of small extent, covering in all an area of about 3 square miles. It is found around the heads of some of the smaller streams in the Coosa Valley or bordering stream courses where the drainage is rather poor. The topography of the type is level. The type is of alluvial origin, the material having been deposited in more quiet waters than the more sandy alluvial soils.

Scarcely any of this soil is being cultivated. It is best adapted to grass or general farming and stock raising. To secure the best results artificial drainage is necessary.

The results of mechanical analyses of soil and subsoil of this type are given in the following table:

Mechanical analyses of Holston silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19845	Soil	0.3	2.9	2.8	13.4	12.9	55.7	12.0
19846	Subsoil	.0	2.1	2.3	12.3	12.1	53.3	18.0

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HUNTINGTON SILT LOAM.

The Huntington silt loam, locally known as "river land," is a brown to dark-brown silt loam about 7 inches deep, underlain by a reddish-brown heavy loam or silty clay. The presence of mica flakes is common in this soil. Occasionally areas of a sandy surface soil appear and where large enough to be mapped on the scale used were classified as Huntington sandy loam.

This type occurs as first bottom skirting the Coosa River and is subject to occasional overflow. The surface is level to undulating and the drainage adequate.

The Huntington silt loam is derived in part from alluvial material brought down by the river. The underlying Conasauga shale formation oftentimes enters into the composition of this soil.

Practically all of this soil is under cultivation. No other soil in the county is so extensively used for the production of corn, to which crop it is well adapted. Cotton is not extensively grown, partly because it is not as well adapted to this soil, also because of injury received from early overflows. An excellent opportunity is here presented for dairying, stock raising, and general farming.

The results of mechanical analyses of the soil and subsoil are found in the following table:

Mechanical analyses of Huntington silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19843	Soil	0.0	0.9	0.9	2.4	5.0	64.0	26.9
19844	Subsoil	.1	1.3	.9	2.3	4.4	57.6	33.2

HUNTINGTON SANDY LOAM.

The Huntington sandy loam is somewhat variable as to texture and depth of soil. These variations occur at such short and irregular distances as to make a separation impracticable. The soil is a medium to fine sandy loam 6 to 18 inches in depth, underlain by a reddish-yellow to yellowish-brown silty sandy clay. This type is found in a few scattering, small areas along the immediate banks of the Coosa River and is subject to overflow.

The Huntington sandy loam is largely of alluvial origin but material similar to that of Conasauga clay, which always appears at depths varying from 3 to 10 feet, also enters to a small degree into the composition of this type. Much of the soil material is of more recent deposition by the river than the second-terrace alluvial soils of the area. The surface of this type is undulating and the drainage adequate.

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Corn is practically the only crop grown on this soil and very good yields are secured. Cotton is not grown to any extent because of the danger of overflow. This soil is well adapted to melons and most of the garden vegetables.

The following table gives the results of mechanical analyses of the soil and subsoil of this type.

Mechanical analyses of Huntington sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19865	Soil	0.1	2.9	19.6	46.6	10.7	15.2	5.0
19866	Subsoil	.0	3.5	16.8	35.4	6.5	19.0	18.3

CONASAUGA CLAY.

The Conasauga clay is the heaviest soil found in the county. To a depth of about 6 inches it consists of a yellowish-brown clay loam or clay, underlain by a yellow or reddish-yellow, heavy, impervious plastic clay. The surface 2 to 4 inches of soil is sometimes a light-gray fine silt which is probably a river deposit. The largest area of this phase lies southeast of Gadsden. Waterworn gravel is also common over the surface of the type, but seldom occurs in such quantities as to interfere with cultivation. This clay soil is of a very plastic nature when wet, and hard when dry, and at certain moisture stages is very tough and sticky, making traveling over it quite difficult.

Areas of this type are confined entirely to the Coosa River Valley. The largest body lies southwest of Gadsden and others less extensive are found toward the east. The topography is level to undulating. The natural surface drainage is sufficient except in a few localities where artificial drainage is required.

The Conasauga clay is derived from the disintegration and breaking down of the underlying Conasauga shale formation. The seams of limestone appearing in this formation probably have little or no influence upon the soil. The close and impervious nature of the soil so seriously affects the movements of soil moisture that during the hot summer crops do not get the amount of moisture required and therefore become stunted and either do not fruit at all or make inferior yields. To overcome this condition and improve the structure of the soil the incorporation of organic matter, by applying stable manure or by turning under green manuring crops, and liming are strongly recommended. Only a few fields are under cultivation and many have been abandoned. Cotton and corn are the only crops grown and yields scarcely repay the cost of production.

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This type is best adapted to hay and stock raising. It ranges in price from $3 to $10 an acre.

The average results of mechanical analyses of soil and subsoil of the Conasauga clay are given in the following table:

Mechanical analyses of Conasauga clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19839, 19841	Soil	2.3	7.4	2.2	3.6	2.4	57.3	24.5
19840, 19842	Subsoil	.3	2.9	1.8	4.2	1.9	31.7	57.1

HAGERSTOWN LOAM.

The Hagerstown loam to a depth of 8 to 12 inches consists of a yellowish-brown loam, underlain by a reddish-yellow or yellow loam grading at about 2 feet into a clay loam or clay.

The type occurs in the narrow limestone valleys between the several mountain ranges, being most extensively developed in Big Will's Valley, though found in various other parts of the county.

The floors of these valleys are undulating to gently rolling and intersected by small streams; consequently they are well drained.

The Hagerstown loam is of residual origin, being the result of the breaking down and weathering of Bangor, Chickamauga, and Knox dolomite limestones. Bordering the edges of these valleys there are occasionally small areas over which lies a thin mantle of fine material which has found its way down from adjacent slopes.

The Hagerstown loam is one of the most extensively cultivated soils in the county and was one of the first to be cleared for cultivation. It has been used almost exclusively for the production of cotton and corn, to which crops it is well adapted. Tobacco could be profitably produced. It is also well suited for general farming.

The agricultural value of the Hagerstown loam depends largely on location, its price varying from $15 to $35 an acre.

The results of mechanical analyses of soil and subsoil are given in the following table:

Mechanical analyses of Hagerstown loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19863	Soil	0.0	0.5	1.4	13.1	15.4	52.5	17.2
19864	Subsoil	.0	.4	1.0	10.4	8.0	53.6	26.4

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HAGERSTOWN STONY CLAY.

The Hagerstown stony clay to a depth of about 6 inches is a yellowish-brown to brownish-yellow clay loam or clay, underlain by a yellowish-brown or yellow heavy tough clay. Limestone fragments are found on the surface and throughout the soil mass; also rock outcrops are frequent.

The type occurs in narrow bands along the lower slopes and base on the northwest side of Lookout and Red mountains.

The Hagerstown stony clay is the result of the weathering of Chickamauga limestone. The slopes are rather too steep and rough and the surface too stony for the profitable cultivation of the staple crops, though well adapted to the production of apples.

The results of mechanical analyses of this type of soil are shown in the following table:

Mechanical analyses of Hagerstown stony clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19861	Soil	2.3	7.5	2.4	4.2	7.1	48.2	28.3
19862	Subsoil	.2	1.1	1.3	7.9	5.0	23.3	61.1

DECATUR CLAY LOAM.

The Decatur clay loam is very limited in extent, the aggregate of the three small areas found being not more than 2 square miles. The soil to a depth of 8 inches consists of a reddish-brown clay loam grading at from 18 to 24 inches into a stiff red clay.

The type is found within areas of Hagerstown loam, and is most typically developed in the vicinity of Turkeytown. The topography is undulating or gently rolling and the drainage good.

This type is the result of the weathering and breaking down of the Knox dolomite formation, containing little, if any, chert.

All of the Decatur clay loam is under cultivation and cropped almost exclusively to cotton and corn, very good yields of both being secured. It is an excellent soil for general farming; also for grasses. It is generally considered a stronger soil than the Hagerstown loam.

The results of mechanical analyses of soil and subsoil are given in the following table:

Mechanical analyses of Decatur clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19851	Soil	0.4	3.2	2.3	5.0	7.2	48.9	32.8
19852	Subsoil	.9	3.1	2.0	3.8	5.2	46.3	38.5

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HANCEVILLE LOAM.

The Hanceville loam consists of about 6 inches of reddish-brown heavy loam underlain by a lighter colored reddish-brown clay loam or clay.

The type occurs in bands on the tops of ridges, mainly on Lookout Mountain. One small area is found about 2 miles north of Aurora. The surface is gently rolling and occasionally hilly, and the drainage is good.

The Hanceville loam is a residual soil derived from the breaking down and weathering of the underlying sandstone formation, probably Lookout sandstone.

This is the strongest mountain soil in the area. It is best adapted to general farming. Very good yields of corn and forage crops are secured. Some peaches are grown, but it is not considered an especially good soil for this crop in that the keeping quality of the fruit is not satisfactory. Apples would undoubtedly do well. Prices paid for this land vary from $3 to $15 an acre.

The following table gives the results of mechanical analyses of the soil and subsoil of the Hanceville loam:

Mechanical analyses of Hanceville loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19869	Soil	0.3	3.8	13.4	26.1	3.5	27.2	25.5
19870	Subsoil	.0	3.2	10.6	20.2	4.4	24.9	36.7

LOCUST SILT LOAM.

The Locust silt loam to a depth of about 14 inches is a grayish-yellow silt loam and grades into a strong yellow silty clay. At from 5 to 7 feet below the surface is often found a stratified layer 6 to 8 inches thick of angular chert gravel.

Areas of this soil are confined to Murphree Valley in the northwestern part of the county. They vary in width from one-fourth to three-fourths of a mile and lie along Locust Fork of Black Warrior River and its tributary, Bristow Creek. The surface of the type is slightly undulating, with the drainage toward a stream flowing down the center of the valley.

The Locust silt loam is apparently an alluvial soil, having been deposited by water. It is a fairly strong soil and all of it is under cultivation, producing very good yields of cotton and corn. It is best adapted to the production of hay and to stock raising and general farming.

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The results of mechanical analyses of the soil and subsoil are given in the following table:

Mechanical analyses of Locust silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19867	Soil	1.0	2.0	1.4	4.2	6.5	66.7	17.9
19868	Subsoil	1.3	2.3	1.3	3.9	16.0	48.4	26.9

MEADOW.

The type mapped as Meadow includes first bottom lands occurring as marginal strips along some of the smaller streams. The variableness of the soil in such features as texture, color, and structure, occurring at such short and irregular intervals, makes a separation impossible. This soil is subject to inundations, but these are seldom of such duration as seriously to affect crops. The type is of recent alluvial origin, being composed largely of a mixture of material from adjacent uplands. Position and manner of formation are the chief factors in making the separation. The Meadow is largely forested, and with few exceptions no attempt has been made to bring it under cultivation. If artificially drained by straightening some of the streams and cutting a few ditches to provide for seepage water, this soil would be very desirable for corn and the more sandy areas for many of the vegetables.

ROUGH STONY LAND.

Rough stony land is a term applied to broken, stony areas of no value except for the small amount of timber and sparse pasture they afford. The character of the soil varies with the different underlying formations. Here it is derived from sandstone similar to that of the Dekalb soils which always border these areas. A number of areas of Rough stony land too small to show on the soil map occur in different parts of the Dekalb fine sandy loam, sandy loam, and stony silt loam.

SUMMARY.

Etowah County lies in the northeastern part of Alabama and covers an area of 542 square miles. The elevation of the county varies from about 500 to about 1,500 feet and the topography is characterized by valleys, plateaus, and mountains. The main drainage is toward the southwest to the Gulf and is effected largely through the Coosa River and its tributaries.

Gadsden, the county seat, is the largest town, with a population of about 8,000. Alabama City, a manufacturing town 2 miles west

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of Gadsden, has a population of about 2,500, and Attalla, with a population of about 2,000 and 3 miles still farther west, is another important town. Iron furnaces are located at each of these towns. At Alabama City there are also a large cotton mill and a steel plant, and at Gadsden several factories employing several hundred men. Atlanta, Chattanooga, and Birmingham are all less than three hours distant.

Etowah County is well supplied with railroads, five lines entering one or more of the three towns in the center of the county. The Coosa River is navigable up as far as Rome, Ga., and to the shoals 20 miles below Gadsden.

The climate is favorable to the production of a wide variety of crops. The summers are long and pleasant and the winters short and mild. The so-called winter crops suitable for stock raising may be relied upon through the winter. The annual precipitation of about 55 inches is ample for all crops grown. The average growing season for tender vegetation is between six and seven months.

Cotton is the all-important crop, and corn is next, though grown only for home consumption. A comparatively small acreage is devoted to wheat, oats, sorghum, peas, peanuts, hay, vegetables, and tobacco. Cattle raising is also being carried on to a small extent.

The farmers of the county in order to maintain the productivity of their soils should adopt thorough tillage methods and a system of crop rotation. The adaptation of soils to crops should be recognized and a greater diversity of crops grown. Other crops than cotton would be more profitable on much of the cultivated land. On some of the heavier soils suited to forage crops, dairying and stock raising would be promising industries, and in some localities the production of fruit, especially peaches and apples, on a larger commercial scale would prove remunerative. Certain soils in the county under proper treatment are adapted to tobacco and truck crops, and other crops might be introduced with profit.

Much of the labor on the farms is done by negroes, though during the busy season the white farmer and his family work in the fields. Most of the farms, particularly in the mountainous section, are cultivated by the owners.

The prices paid for farm land vary from $3 to $40 an acre, according to the kind of soil and the location of the farm.

Etowah County forms a part of the great Appalachian province. The rocks exposed are all of sedimentary origin, belonging to the Paleozoic age, and consist of crumbled and folded shales, limestone, conglomerates, and sandstones, varying in degrees of purity and hardness. The underlying strata contain workable quantities of iron, coal, and limestone.

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All of the soils of the county, except alluvial and colluvial strips, which represent a mixture of material from several formations, are derived directly from the decay and disintegration of the rocks on which they lie.

Twenty soil types were mapped in the county, varying from heavy clays to sandy loams.

The Dekalb soils, derived from sandstones and shales, cover practically the entire mountainous section of the county. The silt loam, fine sandy loam, and sandy loam are the farming lands of this district.

The Dekalb silt loam, one of the extensive types, is best adapted to grasses and general farming. Cotton produces from one-fourth to five-eighths of a bale and corn from 5 to 10 bushels per acre, the yields depending upon the methods of cultivation.

The Dekalb fine sandy loam is probably the most extensively developed and widely cultivated soil on Sand Mountain. While not naturally a strong fertile soil, it is easily worked and is very susceptible to good methods of tillage and fertilization, the addition of vegetable matter being particularly effective. It is perhaps adapted to a wider variety of crops than any other soil type in the area. Cotton and corn, the principal crops, give good yields. Sweet potatoes, Irish potatoes, melons, and most truck crops do well. On northern exposures peaches and apples are successfully grown. It is probable that this soil is also adapted to tobacco.

The Dekalb sandy loam is, in its adaptability to crops, similar to the Dekalb fine sandy loam, but it is not quite so productive.

The Dekalb shale loam and Dekalb stony silt loam are cultivated only to a slight extent. These types are best adapted to forestry or to pasture. On some portions of the stony silt loam apple and peach orchards would do well.

The Hanceville loam, though not extensively developed, is one of the strongest mountain soils. It is best adapted to general farming. Very good yields of corn and forage crops are secured. Apples would undoubtedly do well.

The narrow limestone valleys present a variety of limestone soils, due to the composition and structure of the underlying rocks. In point of importance are the Hagerstown soils, the loam member of which is the only one extensively developed. Derived from cherty limestone are large areas of Clarksville stony loam and a small area of gravelly loam.

The Hagerstown loam is extensively cultivated to cotton and corn, to which crop it is well adapted. It is also well suited for general farming and for grasses. Tobacco could also be profitably produced.

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The Hagerstown stony clay, owing to its stony nature and rough topographic position, is not used for cultivated crops. It is well adapted to the production of apples.

The Decatur clay loam is very limited in extent. It is the strongest limestone soil found in the county. Very good yields of both cotton and corn are secured. It is an excellent soil for general farming and also for grasses.

The Clarksville stony loam is the most extensive of the limestone soils. Owing to its topographic position and stony nature little of this soil is under cultivation. Staple crops do moderately well. Peaches and apples give excellent returns, the fruit being of good flavor and excellent keeping qualities. On the less stony areas it is believed tobacco can be successfully produced.

The Clarksville gravelly loam produces fair yields of cotton and corn. This soil is best suited for stock raising and general farming.

The Conasauga clay is the heaviest soil found in the county. Owing to the plastic nature of this soil and the difficulty in working it, together with the fact that crops suffer in both very dry and wet weather, causing yields to be low, it is seldom cultivated. Cotton and corn are the only crops grown, and the yields scarcely repay the cost of production.

Rough stony land is a term applied to broken stony areas of no value except for the small amount of timber and sparse pasture they afford.

In the Coosa River valley are large areas of alluvial soils deposited at a time when the stream bed stood at a higher level. These soils are composed of a mixture of material from different formations brought down from points farther up stream and have been mapped as Holston and Huntington soils.

The Holston fine sandy loam is the most extensive of these alluvial soils. It is above overflow, and the drainage is adequate. Practically all the type is under cultivation and is used principally in the production of cotton, with a small acreage given to corn. It is well adapted to cotton, but only fairly well to corn. Most garden vegetables do well, especially potatoes.

The Holston gravelly sandy loam is adapted to about the same crops as the fine sandy loam.

The Holston silt loam is of small extent. Though lying above overflow, it is flat and poorly drained. It is best adapted to grasses, general farming, and stock raising.

The Huntington silt loam, locally known as "river land," occupies first bottom and is subject to overflow. The surface is level to undulating and the drainage adequate. The type is cultivated mainly to corn, to which crop it is well adapted. Some cotton is grown, though

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with less success than corn, partly because of injury from early overflows. This soil offers excellent opportunities for dairying, stock raising, and general farming.

The Huntington sandy loam, which occurs along the immediate banks of the Coosa River, is more liable to overflow than the Huntington silt loam. Corn is practically the only crop grown, and very good yields are secured. The soil is well adapted to melons and most garden vegetables.

Areas of Locust silt loam are confined to Murphree Valley, in the northwestern part of the county. It is apparently an alluvial soil, with undulating surface and good drainage. It produces good yields of cotton and corn. It is best adapted to the production of hay, to stock raising, and general farming.

The type Meadow includes first bottom lands occurring as marginal strips along some of the smaller streams. This soil is subject to inundations of short duration, but these are seldom serious enough to affect crops. When drained it is excellently adapted to corn and many vegetables.

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SOIL SURVEY OF JEFFERSON COUNTY, ALABAMA.

By HOWARD C. SMITH, of the U. S. Department of Agriculture, and E. S. PACE, of the Alabama Department of Agriculture and Industries.

DESCRIPTION OF THE AREA.

Jefferson County, named in honor of our third President, is located in north-central Alabama, on the southern extension of the Appalachian system and in the center of the rich iron, coal, and limestone belt of the South. The county contains 719,360 acres, or 1,124 square miles, and is an irregularly shaped parallelogram, with its longer dimension, 46 miles, from east to west, and its shorter, 38 miles, from northeast to southwest.

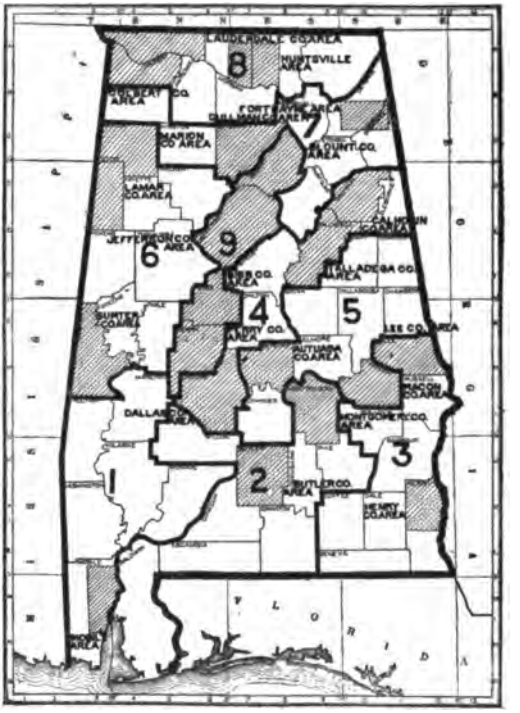

FIG. 18.—Sketch map showing location of the Jefferson County area, Alabama.

Parallel 33° 51′ north latitude lies just within the northern boundary, while the southern extremity is crossed by parallel 33° 15′. The meridian 86° 30′ west from Greenwich touches the eastern side and 87° 20′ crosses the western tip. The county is bounded on the north by Walker and Blount, on the east by St. Clair, and on the south by Tuscaloosa, Shelby, and Bibb, and on the west by Tuscaloosa and Walker counties. The base map used by the surveying party was made by the United States Geological Survey.

The surface of the country is mainly mountainous to hilly and the drainage is well developed, as shown by the numberless rounded hills, valleys, and the much dissected surface.

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In 1817 Alabama was organized as a Territory, and in 1819 admitted as a State. At the first session of the legislature Jefferson County was formed from the southern portion of Blount County. Since 1890, however, a part of Jefferson has been annexed to Walker, and a portion of Shelby joined to Jefferson. In 1815 a fort had been erected near Old Jonesboro and a colony of Tennesseans had settled near Woodlawn. Most of the early settlers were from Tennessee, Kentucky, and the Carolinas. The land was then in forest. Jones and Opossum valleys were cleared first and necessaries like corn, oats, wheat, beef, and pork were produced.

The mild climate, fertile soil, and river communication caused the population to increase rapidly. The following table shows the remarkable development since 1830—a development due mainly to the commercial exploitation of the great deposits of limestone, red and brown iron ore, and bituminous coal.

Population of Jefferson County, Ala., 1830 to 1900.

Year.	Population.	Year.	Population.	Year.	Population.
1830	6,835	1860	11,746	1890	88,501
1840	7,131	1870	12,345	1900	140,420
1850	8,989	1880	23,272		

At present the population is chiefly in the cities. The inhabitants are cosmopolitan, including Europeans, most of whom labor in mines and public works, and people from all States who have been attracted by the varied industries and rich possibilities of the country. Birmingham, the county seat, has now an estimated population of 150,000, while Bessemer and Ensley are flourishing cities that have doubled their population during the last few years.

At present there is no water communication to the sea, but the transportation of the county is carried on by nine main railroad lines that cover all the county except the extreme western portions, in the mountainous districts. The following railroads enter Birmingham: Alabama Great Southern; Alabama, Birmingham and Atlantic; St. Louis and San Francisco; Central of Georgia; Mobile and Ohio; Louisville and Nashville; Seaboard Air Line; Illinois Central; and Southern. A well-developed system of street and interurban freight and passenger electric lines connect all points between Birmingham and Bessemer. There are many jobbing and wholesale houses that import foodstuffs and the varied necessities of a densely populated industrial center. It is asserted that about 28,000 carloads of alfalfa and other classes of hay are annually shipped in from a dozen near-by States. In spite of the fact that two good crops of Irish potatoes

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can be raised annually, these and other vegetables are shipped in from Wisconsin and other northern States. These fruits and vegetables necessarily bring high prices and could be more cheaply grown at home.

Nearly all the county has rural free delivery. There is a good system of rural schools, high schools, and several colleges. The county is traversed by over 1,100 miles of wagon roads, 220 miles of which are macadamized. Other roads are being rebuilt, and this work will be continued until all the main roads are improved. With the abundance of limestone for cement, and accessible sandstone and chert, road improvement is easily and cheaply carried on.

CLIMATE.

Jefferson County has a mild climate, usually free from extremes of heat or cold. The extreme range of elevation is from 1,400 feet on Butler Mountain to 240 feet above sea level at the junction of Locust Fork with the Warrior River in the southern part of the area. On the majority of farm lands, which lie at elevations ranging from 500 to 800 feet, there are no marked climatic differences due to elevation. On the low-lying Huntington soils, however, late spring and early fall frosts come later and earlier than in the higher areas, and may interfere with the ripening of cotton.

On the higher mountains near Birmingham the elevation produces a refreshing coolness, making those places favored for summer resorts. On only two occasions in thirteen years has the temperature exceeded 100° F., and only once during this time has the thermometer registered below zero. It is not unusual for the temperature to approach 15° or 20° below freezing, but even such extremes are of short duration.

The average temperature for December, January, and February is 48°, which gives frequent frosts, slight freezes, or quickly disappearing flurries of snow. It is only rarely that field crops or fruits are damaged. The average dates for killing frosts at Birmingham for the last thirteen years are March 19 and November 5, giving an average growing season of 231 days, or nearly 8 months, although there may be considerable seasonal variations. The mild, equable climate thus permits the maturity of nearly all the great staple crop produced farther north, and in addition many suited to semitropical latitudes may be grown.

At Birmingham the average annual rainfall is about 57 inches, which is ample for all crops. While it is normally well distributed, there are occasional dry periods in August or September. Unless carefully and frequently cultivated, so that a crust does not form on the soil, late-sown crops may have their yields diminished. However, cotton when well cultivated seldom suffers from drought.

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In winter it is common to have several warm bright days followed by a rain and colder weather, which gradually becomes warmer. On account of the cloudy nights it is not unusual for several weeks to pass without a frost. The climate permits the growth of the hardier garden vegetables during all the winter. With a ready demand, high prices, and cheap fuel, and this climatic adaptation, the production of tender plants under glass would seem to be an industry that might well be introduced.

High winds are rare and do little damage. During the spring, summer, and fall thunder showers are frequent, usually coming from the southwest. The dry air, sunshiny weather, and absence of damp foggy days operate to make the climate exceptionally healthful.

Normal monthly, seasonal, and annual temperature and precipitation at Birmingham.

Month.	Temperature.			Precipitation.			
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year.	Total amount for the wettest year.	Snow, average depth.
	°F.	°F.	°F.	Inches.	Inches.	Inches.	Inch.
December	48	73	5	5.1	1.1	4.0	Trace.
January	46	75	10	5.7	3.4	5.2	Trace.
February	49	81	−10	4.2	4.4	6.2	0.6
Winter	48	.....	.....	15.0	8.9	15.4	.6
March	57	87	12	6.4	4.4	6.8	Trace.
April	64	90	28	6.2	4.9	13.1	.0
May	73	97	40	3.9	3.2	2.3	.0
Spring	65	.....	.....	16.5	12.5	22.2	Trace.
June	79	100	49	4.8	4.3	12.1	.0
July	81	104	59	5.4	3.4	7.9	.0
August	80	101	61	5.5	2.3	2.0	.0
Summer	80	.....	.....	15.7	10.0	22.0	.0
September	75	100	42	2.8	.7	3.8	.0
October	65	93	31	3.0	1.3	7.2	.0
November	54	84	18	3.8	3.8	5.8	Trace.
Fall	65	.....	.....	9.6	5.8	16.8	Trace.
Year	64	104	−10	56.8	37.2	76.4	.6

AGRICULTURE.

The first settlers in Jefferson County began farming on the Decatur and Hagerstown soils. The farms were obtained from the Government, under what was known as the "'Bit' law," by the terms of which 12½ cents per acre was paid for the land.

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With the clearing of the virgin forest of pine, cedar, gum, and hardwoods, the pioneers grew crops of corn, wheat, and oats. The mild climate and fertile soil made the region attractive, and wealthy planters soon bought the cheap lands. Other settlers flocked in, and by 1850 the population was 8,989. However, the large landowners began an agricultural land monopoly that absorbed the smaller holdings, and gradually the agriculture came to be carried on by slave labor. Many of the planters owned several thousand acres of land. Cotton was generally grown, although large numbers of cattle and hogs and quantities of sweet potatoes, corn, and wheat were grown for sale and home consumption.

Cotton was marketed in Tuscaloosa and Mobile. Corn has always been a leading crop and the census reports show the acreage to have been double or treble that of cotton. While the first crops of cotton were large, the yield is universally claimed to be greater now than in antebellum days, owing to improved methods of handling and fertilizing the soil and to better seed selection. In the early days it was the custom to plow the land 2 or 3 inches deep and to give little attention to the maintenance of the lands in a productive state, consequently the fields rapidly declined in yield. They were then allowed to "lie out" or to become reforested. During the late sixties and for some time thereafter agriculture was much depressed, but gradually a new system of farming was evolved. One prominent feature has been the division of the vast estates into smaller tracts—a change still in progress—and another has been the development of the tenant system of farming.

In 1880 the average sized farm was 132 acres; ten years later 116 acres. In 1900, 76 acres is given as the average size, but in this census the area cultivated by each tenant was classed as a separate farm, so that the average size of individual holdings is larger than the figure given. Owing to the development of the trucking industry and the scarcity of labor which forces farmers to operate only such tracts as they can care for themselves, it is likely the farms will be still smaller in the future. Each census has shown an increase in the acreage of improved land, the increase in the last decade being from 75,706 acres in 1890 to 103,570 in 1900, a gain of over 25 per cent. It seems certain that the past decade has shown a still greater increase, though no definite figures are available. The change in tenure in recent years is shown by the census figures. In 1890, 79.2 per cent of farms were operated by owners; in 1900, 57.7 per cent. In view of the decrease in size of farms, and in the number operating their own farms, the increasing tendency toward renting is apparent.

During the early period following the war the acreage of corn and cotton increased, the latter gaining more slowly than the former,

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while the growth of wheat declined, the crops mentioned being more profitable. Within the last ten years there has been an increase in the production of certain subsistence crops.

The relative importance of the staples can be apprehended by a glance at the figures given by the late censuses. In 1889 there were grown 36,499 acres of corn, producing 13.3 bushels per acre. In 1879, 14,220 acres of cotton produced 5,333 bales, or 187 pounds, of lint per acre; while in 1899, 18,224 acres produced 7,044 bales, or 193 pounds, per acre. In 1889 all farm yields were above the average, and cotton yielded 204 pounds of lint per acre. With the building of the Alabama Great Southern Railroad in 1871, fertilizers began to be used, outside markets could be more easily reached, Birmingham was founded, iron and coal were mined on a commercial scale, and a new agricultural and industrial epoch started. Thus there followed a gradual extension in the acreage of improved land and an increase in land values. The industrial development has, however, been so rapid that agriculture has not kept pace with it. In spite of the extremely high prices paid for all farm products, the county produces but an insignificant fraction of its foodstuffs. At present, even with the increasing prices for land, it is not unusual for a farmer to buy land and sell enough truck to pay for it in from one to three years. Notwithstanding this and the abundance of truck soil, the industry is in its infancy, the bulk of the vegetables coming from outside the State.

Aside from market gardening, the present farming consists of cotton as the money crop, and corn, with oats, cowpeas, sweet and Irish potatoes, and sorghum or sugar cane as secondary crops. While improvement in the character of farm machinery used and in cultural methods is in progress, the present farm practices in general do not differ materially from those in other cotton States. The land is generally plowed in the fall or winter to a depth of 2 or 3 inches only, and allowed to lie till planting time. The common practice is to turn the last season's row into the middle furrow, thus changing the position of the rows each year. A practice productive of better results on a few farms is to plow deeply in the fall, using a two-horse turning plow, and to sow oats as a winter cover crop. In the spring the beds can be made in the usual manner. This gives a deeper, better seed bed, two cultivations instead of one, a winter cover crop to lessen washing, and enables the soil better to withstand drought. A few farmers aim to keep the fields covered with an inch of loose soil, in order to stop evaporation, thus giving the water to the crops, but with the majority the aim is simply to keep the weeds down. In the case of the heavier types of soil, cracks several inches deep may form, and the loss of moisture is rapid. Such soils should never be allowed to form a crust.

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At present many farmers in preparing the old field for plowing drag a log across the rows, breaking down the cotton stalks, which are then raked into piles and burned. As nearly all of the soils have an insufficient supply of humus, this practice is wasteful and should be stopped. A modern stalk cutter should be used, after which the stalks can be readily plowed under, thus adding needed organic matter to the soil.

Unfortunately for the cattle, and the soils also, winter cover crops are not grown, neither are the steep hillsides terraced, and more or less erosion is the result. Deep fall plowing and planting of rye, oats, wheat, hairy vetch, or bur clover, which quickly cover the soil, would lessen washing and result in other benefits. Much of the land, especially where the subsoil is heavy, should be subsoiled, and in general a gradual increase in depth of plowing up to 8 or 10 inches is desirable. This deeper tillage also lessens gullying, making the soils more absorbent, and diminishing the injury from drought.

During the last five years the market-gardening industry has become a leading feature on the soils within driving distance of Birmingham. The gardens are from 1 to 3 acres in extent, and while not farmed as systematically as in older localities where the industry has been long established, in proportion to labor and capital invested they are extremely profitable. Truck land can be rented for from $1 to $5 an acre. The demand for sweet corn is great and two crops can be produced, the first being sold in June and the second in the fall. Watermelons are a general crop on many farms, where the owners make a practice of having something to sell whenever they go to the city. Melons are extremely profitable and succeed best on the sandy soils, though heavy applications of fertilizer are required, and but one crop can be grown in the same field without rotation or a rest of several years. Two crops of Irish potatoes can be grown in seasons of sufficient rainfall. The first crop averages 125 to 175 bushels an acre; the second is expected to yield about 100 bushels. Only one crop can be produced from southern-grown seed.

Sweet potatoes succeed well on all the lighter soils. The yield ranging from 150 to 250 bushels per acre. Although prices are never less than 75 cents a bushel, and often more than $1, only small patches are planted. The "bunch yam" and Dooley are favorites. There is room for the farmer who understands the crop and soil adaptation to grow both kinds of potatoes on a large commercial scale.

Tomatoes do well on all soils, but succeed best on well-fertilized heavier types. In July and August, during market gluts, they may sell as low as 30 cents a bushel, when some may be shipped south. Even at this price they sould be profitable, as yields of over 200

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bushels per acre are often reported. Very early or late tomatoes often bring $1 a basket of less than one-half bushel capacity,

Cabbage should be more generally grown, especially on the Decatur, Upshur, and Hagerstown soils. In July and August there is often a scarcity, large consignments being shipped in from the north.

The Dekalb and limestone soils are well adapted to strawberries and blackberries, although few are grown, and berries are imported from the south and from Cullman County. The price is always high and the culture of these fruits would prove profitable. Large quantities of cantaloupes are grown and marketed at profitable prices. Beets, peas, peppers, cucumbers, kale, spinach, and cauliflower find a ready sale and are well adapted to the lighter sandy Dekalb soils. Turnips are universally grown as a winter crop.

The culture of tree fruits is in a neglected condition. Several years ago many pear orchards were planted. These did well for a time, but have lately been damaged by blight. The Kieffer and the Garber seem most resistant to this disease. Peach culture has been tried, the prevailing opinion being that peaches are not adapted to the soil or climate. Judging from the present lack of care, past failures have been due more to a lack of knowledge concerning the culture and care of the trees than to soil or climatic conditions. The soil survey reports of Blount and Talladega counties,[a] where the climate and soils are similar to those of this county, state that success has been had in growing the Elberta peach. There is little doubt that when the proper cultural methods are understood it will be found that the slopes of the Dekalb shale loam and the stony phases of the silt loam and sandy loam will produce well. Healthy growing trees were often seen on these types. The Clarksville stony loam will also produce a high quality of fruit.

Climate and elevation do not adapt the county to the growing of long-keeping winter apples, but they can be grown and kept until January. Hackworth is a favorite summer fruit, while Ben Davis on the Clarksville and Winesap on the Hagerstown stony loam should do well.

Judging from the abundance of wild plums and grapes, certain of the tame varieties should do well, especially at higher elevations. Few cultivated grapes are seen, but the vines were thrifty and productive. The stony, gravelly, and shaly phases of all soils will produce scuppernongs and muscadines of good flavor.

On the whole, Birmingham, with its increasing population, furnishes one of the best markets in the South for all soil products, and the soils are so well adapted to truck and other subsistence crops that many times the area now devoted to their production could be profitably utilized.

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[a] Field Operations of the Bureau of Soils, 1905, p. 407; 1907, p. 401.

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Although the soil will produce all the standard forage crops, the dairy interests are not extensively developed. The farmer keeps one or two cows for family use. Near Birmingham numerous small dairies of six to twelve cows supply milk for city use. The dairies are frequently examined by a sanitary inspector and the milk is of good quality and meets a ready sale at 25 cents a gallon wholesale or 10 cents a quart retail the year round.

A dairy farm near Birmingham is a model and is equipped with the first cement silo built in Alabama. The owner finds the production of corn ensilage on his Dekalb and limestone soils very profitable, and plans to grow two crops of silage corn annually. On the ordinary soils this should easily be done in good seasons, and the land be greatly improved by the stock kept. Most of the dairy stock consists of grade Jerseys, which under the present system of pasturage and feeding seem to do better than pure-bred stock.

The work stock consists of mules and horses, the former being better adapted to farm work. Such stock is shipped in from farther north and must first be acclimated. With soils well adapted to pasturage there is no reason why mule breeding should not be profitable.

On all farms some poultry is kept. As the price of eggs and broilers is usually low, poultry raising has not been as profitable as other branches of farming.

It is recognized that the lighter soils are better adapted to cotton than the heavy red soils. Good yields are obtained on the latter soils, but the lint is apt to be stained during fall rains. On many farms containing both upland and bottom land soils it is common to grow corn almost exclusively on the bottoms and cotton on the uplands. However, cotton does well on the bottom lands if the crop is planted early and the growth of stalks is not too great. The sandy and light loam soils are preferred for market gardening. The slopes of the Dekalb shale loam are the best fruit soil, and good peach orchards were seen on the Dekalb fine sandy loam. These general adaptations are now usually recognized by the farmers.

The need of crop rotation is beginning to be realized. Many farmers sow cowpeas between the rows of cotton and corn, and all report very beneficial effects. A rotation should be followed not only to keep the soil in the best possible condition, but also to provide food for home use and forage for the live stock. The following rotation, embodying all the desirable features, has been tried and found valuable on Alabama soils: First year, corn, with rows wide apart, cowpeas, soy beans, hairy vetch, peanuts, or crimson clover being sowed between rows at the last cultivation; second year, cotton, in order to get the benefit of the humus and nitrogen added to the soil from the previous year's legume crop. The cotton rows should be spaced so as to cover the previous year's rows of legumes. The cot-

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ton rows should be at least 5 feet apart, in order to give ample room for branching, and some legume should be sown between the rows. Oats should be sown in the fall after the cotton is picked. These are cut in June and cowpeas are sown, giving an additional crop of forage. With this rotation, four crops will be grown in three years and the area farmed will be divided into three parts, with cotton occupying one-third; but abundant experience has shown that a farm thus treated will in a few years give the grower from two to three times as much cotton per acre as under the old management. In addition, the yields of other crops will still further augment his profits. Although local modifications of the rotation may be necessary, the productiveness of the soil can not be kept up by any rotation that, in the absence of barnyard manure, omits the replacement of humus by the growing of green or leguminous crops.

The use of low-grade fertilizer is quite general and has increased from a value of $22,573 in 1879 to $37,040 in 1899. The opinion is that the next census will show that the consumption has doubled in the last ten years. From 100 to 200 pounds an acre is the usual application for cotton. A few farmers who have used 400 to 600 pounds report yields that show greater profits than where a smaller amount is used. The universal verdict that fertilizers are used most profitably where there is an abundance of humus should stimulate all farmers to grow green manuring crops. No efforts have been made to adapt the fertilizer to the crop or to the needs of the soil. The farmer usually buys the brand supplied by his dealer.

Owing to the scarcity of farm labor and the high prices paid in mines and public works, many renters with families have gone to the cities, and this has had a tendency to retard the development of the country agriculturally. Another factor working to the same end is the large land holdings of some of the largest corporations in the United States. The greater part of the area of the country is so held by industrial concerns that will not sell land, but rent it, and only on a cash basis. Naturally these tracts show little farm improvement, and in many places are entirely in second-growth timber. As some of the soil is best adapted to forestry this withdrawal from agricultural occupation is timely. Another reason why agriculture has not kept pace with the industrial development is the natural conservatism of the farmer, which keeps him from changing to more modern systems of farming.

The main dependence for labor is upon negroes and exchange of farm labor between farmers. Wages are higher near the mines, where the farmers must pay nearly as much as the miners receive, although deduction is made for board and lodging. From 75 cents to $1.20 per day is a common wage, and $15 to $18 a month are ordi-

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narily paid for farm labor. The conditions emphasize the great need for the introduction of modern labor-saving farm tools.

Land rents vary from $1 to $4 an acre. This affords a good return on the capital invested. With such a low rental and the high price paid for produce the renters are quite prosperous. Many tenants work the land on a share basis, and on the cotton and corn farms the rule is to pay a third of the cotton and a fourth of the corn. The majority of the farmers, owners, and tenants are white.

Many of the Dekalb soils have two values—the agricultural and the mineral—the latter including coal and iron, or, in the case of the Hagerstown soils, limestone. The agricultural values range from $5 per acre for Rough stony land to $150 to $175 for improved tillable land near the centers of population. Higher values than these are usually due to the desirability of the land for residential use. Owing to the rapid industrial development the county has great agricultural possibilities and farming land in consequence is rising in value.

Turning now to the question of suggestions for the betterment of agriculture, perhaps the greatest benefit will result from the diversification of crops and the practice of systematic crop rotation. Under this system the farmer would be more independent of fluctuations in the price and yield of cotton, and his income would be distributed more evenly through the year. The soils at present are producing but half what they will yield if crop rotation, deep plowing, and more thorough tillage are practiced. But a small amount of hay is produced in the county. Fortunately this hay is largely made of the vines of cowpeas, a crop which is of the greatest benefit to the soil, but the acreage of this and other forage crops should be larger, and on every farm the number of live stock should be increased. The number of mules should be two to each hand instead of one, as at present. Mules and horses are costly, good farm animals bringing from $375 to $400 a team. As stated, these are imported from other States, but there is no reason why they should not be produced at home. Some farmers keep from one to three grade Berkshire hogs, but most of them buy more or less meat for home consumption. They could not only produce enough to supply their needs, but would find it profitable to raise them on a commercial scale. Where hogs have been allowed to graze on peanuts it has been shown that the soil is greatly improved, and this is another reason for increasing their number on the farms. In the rougher lands of the county the grazing of cattle, sheep, and goats would be the best adaptation for the soil.

Few farmers use lime, as they claim the price is prohibitive, but with the abundance of cheap fuel there is no reason why many farmers who have suitable limestone on their farms should not burn it at a reasonable outlay. Contrary to the general opinion of farmers

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on the limestone soils, experiments have repeatedly demonstrated that soils derived from limestone are as often benefited by applications of lime as are soils derived from other kinds of rocks. There is no doubt that applications of 1,500 to 2,000 pounds per acre would prove profitable for all crops. The use of lime will be found especially valuable where alfalfa is to be grown. Owing to the high prices—$18.50 to $23 per ton—paid for alfalfa, there is a desire to grow this crop. Some have attempted it and failed, assigning as the reason a lack of suitable soil. Alfalfa should thrive on deep, well-drained limestone soils, of which there are a number in the county, and it is probable that the failures have been due to improper methods of preparing and seeding the land.

Owing to the dip of the stratified rocks, the soils of the county are, on the whole, well drained. There are, however, many low-lying tracts that are in a wet, cold, unsanitary condition and not producing their greatest yields. Where the soil has a mottled appearance the need of drainage is generally indicated. The conditions can be improved by tile or open drains.

An important problem in the agricultural development of the area, and one which should receive more attention, is the correction of erosion of the fields and hillsides.

SOILS.

The striking topographic features presented in the county are the parallel mountainous ridges and the narrow intervening valleys, all trending in a northeasterly-southwesterly direction. Nine different geological formations, ranging from the variegated shales of the Cambrian to the fine-grained sandstones and shales of Carboniferous age, are seen, and give rise, either directly or indirectly, to thirteen distinct soil types, related in eight soil series, in addition to areas of Rough stony land and Rock outcrop. The youngest of these formations, the Coal Measures of Carboniferous age, covers by far the larger portion of the county and gives rise to the Dekalb soils. Remote from the ridges and valleys of the older formations, the original horizontal bedding of the strata of this formation is in a general way preserved. Near the ridges and the edges of the troughs, where the older underlying formations appear, the sandstones and shales of this formation have been more or less broken, crumpled, and folded. The plateaulike surface of this formation to the north of the parallel valleys has, in many instances, been eroded by streams, with the result that deeply-cut valleys have been formed. The erosion of these streams has not, however, proceeded far enough to expose the older underlying formations, nor has much alluvial material accumulated, so that in general none other than the Dekalb series are developed in this section of the county.

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The geological details in connection with the formation of the valleys of the area are quite complex and will not be entered into here.[a] Briefly, however, the exposure of the limestone and other rocks of the older formations has been effected by an upthrust in long parallel ridges of the earth's crust, elevating all of the formations hundreds of feet above their original position. This upward-bending process cracked and weakened the crests of these anticlinal arches, so that subsequent agencies of weathering and erosion have the better been enabled to attack and wash away the material of the protecting Carboniferous formation. This exposed the softer shales and more soluble limestones of the older formations, and with the weathering and transportation away of masses of this material the valleys of Jones and Opossum creeks and Cahaba River were formed. The comparatively great thickness of the soils of the Decatur and Hagerstown soils of these valleys represent the decay of probably many hundreds of feet of the limestone rock. These valleys, with elevated rims reaching to an average altitude of 600 to 900 feet, have basin-shaped bottoms which are higher than the drainage of much of the surrounding plateau country. The elevation of the Birmingham Valley is 591 feet, while in the western boundary the Locust Fork drains nearly one-third of the county and flows into the Warrior River at an elevation of only 240 feet. About one-fourth of the county south of Red Mountain is drained by the Little Cahaba River, into which flow Patton and Shades creeks; the northern portion is drained by the Warrior River and Locust Fork, into which flow Short, Fivemile, Trouble, Crooked, and Black creeks, and other smaller branches.

The great diversity of the soils of Jefferson County, with their accompanying variations of elevation, slope, drainage, etc., adapting them to a considerable range of agricultural use, results largely from their formation from these rocks of widely varying textural and mineralogical characteristics. The resulting soils range in their texture from the excessively stony members of the Dekalb and Clarksville series, which contain in many places from 50 to 75 per cent of sandstone and chert fragments, through the light-textured Dekalb fine sandy loam, to the heavy Wabash and Conasauga clays. The depth of the soil material varies from a few inches in the rougher portions of the county to many feet in the case of the Huntington, Decatur, and Hagerstown soils.

In topographic position the soils range from the level Huntington silt loam to the mountainous Rough stony land and the knolls

[a] The reader interested in these geological details is referred to the report upon the Coosa Valley Region, by Dr. E. A. Smith, state geologist of Alabama, and to other reports by the state and national surveys.

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and ridges of the Clarksville stony loam. As already stated, the Dekalb series is derived from the Carboniferous rocks, the silty and sandy members occurring where the topography is smoothest and conditions for the accumulation of a comparatively deep, fine-textured soil most favorable. Among these Carboniferous rocks are found irregular knobs, narrow droughty ridges, and long trough-shaped valleys.

The Clarksville stony loam owes its origin mainly to the Fort Payne chert formation of the lower Subcarboniferous and to the cherty inclusions in the Knox dolomite formation of the lower Silurian. The greater proportion of this type occupies the cherty hills and ridges northeast of Birmingham between Red Mountain and Sand Mountain, ending in mountains of Rough stony land farther north.

The Upshur stony loam is derived from the Clinton iron ore of the Red Mountain formation, which, upon weathering, gives rise to a soil along the exposed narrow ridges.

The Conasauga clay and certain phases of the Hagerstown soils are derived from the Flatwoods or Coosa shales of Cambrian age, which are characterized by shales and interbedded limestones of nearly vertical inclination.

The Knox dolomite and the Trenton limestone contribute most largely to the formation of the Decatur and Hagerstown soils occupying the Jones and Opossum valleys, though in the case of the Hagerstown stony loam more or less of the stony material comes from the cherty formations giving rise to the Clarksville stony loam.

The Huntington silt loam, Huntington gravelly loam, and Wabash clay are alluvial soils derived from sediments deposited by streams at times of high water, and are still in process of formation.

The following table gives the names and areas of the several soil types shown on the accompanying map:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Dekalb shale loam	253,632	35.3	Hagerstown stony loam	11,392	1.6
Dekalb silt loam	210,816	29.3	Upshur loam	4,608	.6
Clarksville stony loam	73,664	10.2	Upshur stony loam	2,368	.3
Dekalb fine sandy loam	60,672	8.4	Huntington gravelly loam	2,304	.3
Hagerstown loam	24,768	3.4	Wabash clay	512	.1
Rough stony land	24,320	3.4	Rock outcrop	320	.1
Decatur clay loam	21,184	2.9			
Huntington silt loam	16,896	2.4	Total	719,360	.....
Conasauga clay	11,904	1.7			

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UPSHUR LOAM.

The surface soil of the Upshur loam to a depth of 8 inches is a deep Indian-red or brown loam or silt loam, containing numerous iron concretions and decomposed fragments of iron ore and sandstone, with a large number of bowlders scattered over the surface. The subsoil to a depth of 36 inches is a heavy clay loam or clay containing an increasing amount of crumbly ferruginous sandstone with depth.

The type is the result of the decay of highly ferruginous sandstone. It occurs as a relatively narrow area on the high ridges which form a part of Red and Shades mountains, and contains numerous iron mines. On account of its rough and mountainous topography, very little of the type is under cultivation. However, when farmed, good yields of cotton and corn are secured, and it appears to be a strong soil. At present it is mainly forested with longleaf and shortleaf pine and oaks. It is probably best adapted to fruit growing and forestry.

As the type is held mainly for its mineral rights, it is difficult to estimate its agricultural value. When capable of cultivation, however, it should bring $10 or $20 an acre.

The following table gives the results of mechanical analyses of fine-earth samples of the soil and subsoil of this type:

Mechanical analyses of Upshur loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
20270	Soil	8.0	14.1	4.5	11.4	11.0	38.6	12.6
20271	Subsoil	7.2	16.1	4.7	11.0	9.4	29.9	21.6

UPSHUR STONY LOAM.

The soil of the Upshur stony loam to an average depth of 9 inches is a red sandy loam, the immediate surface being gray when dry. The subsoil is a heavy sandy clay tending to a clay loam at 36 inches.

The surface is hilly and mountainous, consisting of long ridges with steep slopes on each side. Some of the type is very stony, while a portion is rock outcrop. It is derived from a brown sandstone belonging to the "Coal Measures," the rock not being exposed to form soil, except in steep areas on the crest of Shades Mountain.

The native growth on this type consists of oak and other hardwoods. When tillable the soil seems naturally strong, being able to hold moisture and fertilizers well. Yields of truck, cotton, and corn above the average are reported. The growing of cowpeas with the corn and cotton would be profitable. The only field of alfalfa seen in the county was on this type, and it appeared to be making a satis-

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factory growth. The more stony areas should be allowed to remain in pasture.

The building of summer cottages and hotels on this type of soil outside of Birmingham has stimulated the growing of truck, to which it is particularly suited in certain areas because of a loose, open, granular structure, caused by the particles of clay tending to adhere to the sand grains, giving it the appearance of a sandy loam.

Owing to the limited area of this soil and its distance from market, it has a rather low value, from $5 to $15 an acre.

The following table gives the average results of mechanical analyses of fine-earth samples of the soil and subsoil of this type:

Mechanical analyses of Upshur stony loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
20266, 20268.....	Soil.....	0.1	2.9	9.8	34.9	11.7	21.1	19.3
20267, 20269.....	Subsoil.....	.0	2.9	7.9	33.0	12.8	18.6	24.8

DEKALB FINE SANDY LOAM.

The surface of the Dekalb fine sandy loam to an average depth of 8 inches is a light grayish yellow fine sandy loam when wet, becoming gray when dry. On the flat-land areas it contains few, if any, stones, while on the high mountain ridges and slopes it may carry a variable percentage of flat sandstone, with occasional bowlders. On the ridges south of Jones Valley and in the southern part of the county near the Tuscaloosa County line the increased amount of flat shale results in a stony loam phase. This does not differ greatly from the true type.

A peculiarity often noticed is the large amount of clay and silt around each grain of soil, and frequently this gives the soil the appearance of containing a much higher percentage of sand than is really the case. On the slopes the percentage of sand is greater and the soil deeper than in the more level areas.

From 8 to 36 inches the subsoil is a brownish-yellow fine sandy loam to sandy loam, which becomes heavier with depth, tending toward a loam in texture. In some places, notably near Warrior, the subsoil is red, but no appreciable difference in crop yields could be detected in areas of this phase. In other cases the subsoil may be mottled yellow and red or grayish and red. In some cases the subsoil at 36 inches becomes a sandy clay.

The Dekalb fine sandy loam is naturally well drained, is not considered droughty, and the retentive subsoil is not so compact as to prohibit the passage of gravitational water downward or the upward rise of capillary moisture in times of drought. It is generally easy of

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cultivation, can be plowed when quite wet, and does not bake. Much of the type is located north of Opossum Valley and is within easy reach of market or shipping points. This location, together with its adaptation to market gardening, make it a favorite with truckers.

The Dekalb fine sandy loam is a residual soil derived from the disintegration of the underlying stratified sandy shales and sandstones composing the "Coal Measures."

Originally the type was heavily forested, mainly with longleaf pine, with a tendency for different species of oak to predominate in the second growth.

From 10 to 15 bushels of corn and from one-fourth to one-third bale of cotton per acre are average yields on this soil, although occasionally larger yields are reported where fertilizers are used and deep tillage and crop rotation practiced.

Although the above crops give profitable yields, the land is better adapted to truck than any other crop. During seasons of average rainfall two crops of Irish potatoes can be grown on the same soil. The yield of the second crop is usually about one-half of the first, but even then it is profitable. When well fertilized, yields of 100 to 150 bushels per acre are secured. But one crop of sweet potatoes can be produced, yielding from 150 to 200 bushels per acre.

Spanish peanuts have been grown to some extent with profitable results. When fertilizers are used excellent yields of watermelons are reported. Growers receive from 10 to 20 cents for the melons, according to size.

Some truckers raise two crops of corn. Adams Early is ready for marketing in June, and a second crop may be sold for eating or matured for seed. With this intensive culture rotation is necessary, especially in the case of watermelons, which will not grow well on the same soil for two years in succession. In addition to the crops mentioned the other market garden crops succeed well.

Where the intensive garden systems prevail 2 or 3 acres is all one man can manage without hired labor. The truckers usually haul manure from the city and also have a farm compost heap. Large amounts of commercial fertilizers are used with good results. Little attention is paid to adapting the fertilizer to the soil or the crop, any kind of mixture handled by the local dealers being used.

In July and August the yields of truck are often seriously lessened by dry weather. If the land were plowed three times as deep as at present and stable manure applied, the water-holding capacity of the soil would be increased to a point where crops would suffer little in ordinary droughts. On truck lands cowpeas need not be grown unless the supply of humus can not be maintained by the use of stable manure.

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Land of this type, excepting areas close to Birmingham, is held at $10 to $15 an acre, depending on location, improvements, and nearness to market.

The following table gives the average results of mechanical analyses of fine-earth samples of the soil and subsoil of this type:

Mechanical analyses of Dekalb fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
20246, 20248.....	Soil.....	0.2	4.5	13.1	33.4	13.4	25.3	9.5
20247, 20249.....	Subsoil.....	.2	5.2	10.8	25.4	10.9	23.1	24.3

DEKALB SILT LOAM.

The soil of the Dekalb silt loam to a depth of 4 to 6 inches is a gray or ash-colored silt loam. When dry it has a very floury texture and a loose, open structure. In certain flat areas, notably south of Red Mountain, the soil has a higher percentage of subangular shale fragments and silt than elsewhere. This phase, while not largely developed, on account of its low situation is better able to withstand droughts than the more uneven areas. The proportion of sand of the finer grades is somewhat greater in areas where erosion has not been active.

The subsoil, from 8 to 36 inches, is a mottled reddish-brown and yellow heavy silt loam or in areas limited to a few acres a clay loam. Often on eroded areas the subsoil grades into a mass of disintegrated shale fragments at from 3 to 4 feet below the surface.

It is often hard to determine the boundaries between the shale loam and silt loam. However, the subsoil of the silt loam is always deeper and contains less shale chips than the shale loam. On high knobs or long ridges the subsoil may be red, but no agricultural difference could be noted in this phase, excepting that in wet seasons on account of its location it is better drained.

The Dekalb silt loam as a rule is not stony, but on the steep slopes there are outcrops of rock and areas with rough broken surface. Such areas are shown on the map by symbols.

In certain areas in the valley south of Leeds the coloring matter from the higher lying Upshur soil seems to have leached over the Dekalb, giving the soil a red color closely resembling, according to depth, that of the Upshur or Decatur soils. These areas were mapped either as the one or the other type in accord with the predominating characteristics.

While the Dekalb silt loam does not gully like the shale loam, on the steep slopes there is always a constant removal of surface soil to

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lower levels, which occasions considerable variability in the depth, and consequently in the productivity of the soil.

The soil has the greatest area of any type in the county, and with others of the Dekalb series covers nearly the entire county outside of Jones, Cahaba, and Opossum valleys. The topography is mountainous to hilly and consists of highlands cut by streams into knobs and troughlike valleys. Most areas are situated near Birmingham or on railways or macadamized roads and the diversified products can be placed in good markets.

The Dekalb silt loam owes its origin to the breaking down of rocks of the Carboniferous age. These are mostly fine-grained sandstone and finely bedded shale. In places where the type joins the limestone soils fragments of chert and silicious limestone also occur, but the admixture of such material is too limited to have any influence on the agricultural value of the land.

Forests of oak, longleaf pine, and gum, with a scattering of beech, chestnut, and hickory, cover much of the type. The forested areas are utilized for pasture and afford fair grazing for seven months in the year.

As a rule, the Dekalb silt loam is easily cultivated, showing little tendency to pack and clod. It is used for general farming, cotton and corn being the staple crops. Sorghum, oats, and cowpeas do well. On the sandier areas all kinds of truck crops yield profitably, and the areas near markets are now used in market gardening. The same methods of cultivation are practiced as on the Dekalb fine sandy loam, the yields being about the same. A complete fertilizer is used with good results, and where peanuts or cowpeas have been plowed under or stable manure applied the fertilizer effects are even more striking. On the better farmed areas, one-third to one-half bale of cotton and 15 to 20 bushels of corn per acre are grown. Potatoes yield from 150 to 200 bushels per acre. With deeper plowing, crop rotation, and the growing of winter cover crops and cowpeas the yields would be considerably increased.

In common with other types of the county this soil, except in newly cleared fields, is deficient in humus. Many fields should be terraced to prevent washing. The construction of terraces in connection with deeper plowing would control to a large extent, or entirely prevent washing, and reduce the injury from drought. In growing late crops of corn or potatoes such changes in the methods of tillage would be especially valuable.

Considering the rapid industrial development taking place in the county, this type should be used more extensively for the production of fruit and vegetables for the local market and for growing cowpea hay and other forage crops as a basis for dairying. As in the case of the other Dekalb types, the hillier portions should be kept in pasture

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or used for systematic forestry. The lower lying portions of areas adjoining streams are not in all cases well drained. These may generally be reclaimed by open ditches with tile laterals. Near shipping points and within a radius of 20 miles of Birmingham the market gardening has already come to be of some importance, but the possibilities have by no means been exhausted, the growers contenting themselves with small fields of 1 to 3 acres, on which the labor is nearly all done by the grower and his family. With the introduction of modern tools and the hiring of labor, larger areas could be planted and the profits increased in proportion.

This type is badly in need of organic matter. This deficiency, at least in the vicinity of Birmingham, can be supplied with stable manure, which can be had for the hauling. In fact, many stable keepers now make annual contracts for the removal of the manure, paying a fair price for the service.

At present much of the area of the Dekalb silt loam is held by large corporations as mineral lands and is not for sale. Near the trucking region in the vicinity of Birmingham it often sells for $150 an acre. In the hillier and more remote areas the value sinks to $10 an acre, although even here prices have an upward tendency. A common rental is $1 to $2 an acre, or a third of the cotton and one-fourth of the corn. The rent for trucking soils is low, being entirely out of proportion to the cash returns to the farmer.

The following table gives the average results of mechanical analyses of samples of the soil and subsoil of this type:

Mechanical analyses of Dekalb silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18690, 18692, 20254...	Soil.....	0.6	1.6	0.9	7.9	9.3	65.1	14.3
18691, 18693, 20255...	Subsoil....	.5	1.4	.8	5.4	8.2	58.6	25.3

CONASAUGA CLAY.

The Conasauga clay to a depth of 4 inches is a gray or yellowish-gray clay or heavy clay loam of compact structure. The subsoil to a depth of 36 inches is a grayish-yellow clay. Throughout there are outcrops of the gray Coosa shales and in many places such outcrops are so numerous as to prevent cultivation.

The type occurs in portions of Jones Valley near Birmingham and is especially important about Bessemer. It is formed by the solution and disintegration generally of Coosa shales. Sometimes the weathering has been so perfect as to leave level areas having the appearance of extended stream bottoms. The elevation and character of

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the soil, however, leave no doubt of its residual origin. Certain small areas, notably near Canastota and Ketona, are without surface soil, there being a level outcrop of rock sufficiently disintegrated to support a forest of cedar. These low places are spoken of as "flat woods"—a term applied also to similar places having more soil. Often on leaving the lowlands the type merges gradually into the Hagerstown loam.

The Conasauga clay where not cleared for building is mainly in forest of cedar, oak, and gum. On some portions of it wild clover seems to thrive and there are areas used for public pasture. Very little of the type, however, is under cultivation. When cleared it will probably be utilized as pasturage.

The following table gives the average results of mechanical analyses of samples of soil and subsoil of this type:

Mechanical analyses of Conasauga clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
20240,20932	Soil	6.4	9.4	2.9	6.5	4.3	39.6	31.0
20241,20933	Subsoil	1.2	3.8	1.5	3.6	1.8	32.0	56.1

HUNTINGTON GRAVELLY LOAM.

The surface soil of the Huntington gravelly loam to a depth of 8 inches is, when dry, a light ashy-gray very silty loam, having a floury feel and containing a high percentage of angular chert fragments. The subsoil to 36 inches is a brownish-yellow very heavy silt loam mottled with gray and containing much cherty material and gravel.

The description given applies to the area found near East Lake. In the northern portion of the county, however, there are small areas near the Hagerstown loam which are generally composed of wash from the Clarksville stony loam. These often contain larger fragments of chert and both the soil and subsoil are redder. This phase is similar in origin to the Huntington soils, the main difference being that it is derived from stonier and more gravelly soils. The type as a whole is an alluvial wash from higher lying areas of Clarksville, Hagerstown, and Decatur soils, with a predominance of Clarksville material, and the color and texture vary according as the material of one or another of these soils predominates.

The Huntington gravelly loam when well drained and fertilized produces good yields of cotton and corn. Owing to the high percentage of siliceous material and the insufficient supply of humus, the soil is not as productive as the other near-by limestone soils. Much of the type is not well drained and in consequence the crop

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yields are low. On the better drained areas corn yields from 10 to 15 bushels per acre and cotton about one-fourth bale per acre.

Much of the type is located near Birmingham, where, if it were properly drained, it would become a profitable trucking soil. Reclamation may be accomplished by open ditches and lateral tile drains to remove the surplus water and to lighten and warm the soil. With this treatment and the addition of both stable manure and fertilizers, corn and a number of trucking crops could be profitably grown.

Areas of this soil near East Lake, being desirable for building sites, sell at prices in excess of their agricultural value. In other places the price is regulated by the remainder of the farm, usually ranging from $8 to $15 an acre.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of this type:

Mechanical analyses of Huntington gravelly loam.

Number.	Description.	Fine gravel.	Coarse. sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
20256	Soil	1.6	5.1	3.2	8.4	9.0	61.0	12.1
20257	Subsoil	.9	3.0	2.0	5.9	4.8	63.9	19.8

HUNTINGTON SILT LOAM.

The surface soil of the Huntington silt loam, to a depth of 10 inches, is a light-brown friable loam or silt loam of relatively high organic matter content. From 10 to 36 inches the subsoil is usually a light-brown or brown mottled with yellow, and the texture is heavier than the surface soil. Owing to the high percentage of silt, it is friable and breaks readily on boring. It has few stones, except along boundaries near the valley sides, and it does not crack badly in dry weather. The texture is variable, occasional sandy areas being found, but these are not extensive enough to constitute a separate type. In Shades Creek bottom the soils are often whitish or gray in the undrained and untilled areas. Portions of the creek valley mapped as the Huntington series have many characteristics of Dekalb soils, and in many instances it was difficult to separate the types in a satisfactory manner.

The Huntington silt loam is an alluvial type formed by the deposition of material held in suspension by streams at high water. It is found in narrow strips along some of the streams in nearly all parts of the area. Without doubt, the type is the most durable soil in the county. Corn, the principal crop, yields from 25 to 35 bushels per acre, and from one-half to three-fourths bale of cotton can be secured in favorable seasons. In the valleys near cities truck is an

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important product. The soil is adapted to all the staple garden crops. Two crops of sweet corn and a succession of other crops can be raised each year.

Although subject to overflow, the higher lying areas of this type have good drainage, and there are many tracts that could be easily improved by straightening stream channels and installing some drainage system. In many instances irrigation, using a hydraulic ram or steam pump, coal being very cheap, could be profitably carried on. With the development of market gardening on more intensive lines, irrigation will undoubtedly follow.

Fertilizers are not generally used, and it has been found that, notwithstanding the natural fertility of the soil, corn can not be grown in succession more than two or three years without a serious diminution of the yield. When some other crop is alternated with the corn the yields are maintained for a much longer period. Judging from the rank growth of stalk made by both corn and cotton, the soil contains an abundance of nitrogen and consequently only phosphate and potash should be applied. Deeper plowing, since it permits a more extensive root system and the storage of more water, will be found to greatly improve the soil where corn or truck crops are to be grown.

As the type is generally sold in connection with other soils, its agricultural value can not be given.

The following table gives the results of mechanical analyses of fine-earth samples of the soil and subsoil of this type:

Mechanical analyses of Huntington silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
20264	Soil	0.7	1.4	1.9	10.2	12.0	59.0	14.9
20265	Subsoil	2.1	5.6	3.6	8.5	8.9	48.1	23.7

DECATUR CLAY LOAM.

The soil of the Decatur clay loam to a depth of 6 inches or less is a dark reddish-brown clay loam. It has few stones, but a small amount of sand and a variable amount of iron concretions are found. The soil is slightly granulated and consequently is not so adhesive as the subsoil. Nevertheless it is plastic when wet and shrinks greatly on drying, forming surface cracks.

The change from soil to subsoil at about 6 inches is distinctly marked. The reddish-brown color of the soil stops abruptly and is replaced by a light-colored red to reddish-yellow heavy clay loam or clay. The subsoil may extend to a depth of several feet with little

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variation in color and texture. The content of iron concretions and stones is greater than in the surface soil. The deep red color, which becomes lighter with depth, is due to an excess of iron in the soil, some of which may have come from higher lying areas of the ore-bearing rock that gives rise to the Upshur soils.

The deep surface cracks which extend several inches in the subsoil afford an ingress for water during rains. This loosens the soil and aids erosion—a prevailing feature of the type on the slopes which are not terraced and have no vegetation to hold the soil. On all sloping fields the knolls are a lighter red where the surface soil has been washed away. In many cases a large proportion of the fields have been denuded of soil and the yields greatly diminished. In such places corn will barely produce seed, and cotton is unprofitable, until the red subsoil is plowed repeatedly and has had incorporated with it enough humus to form a new soil. With deeper plowing, a more general use of green and stable manures, and terracing, the excessive erosion would be largely stopped. The surface cracks also tend to dry the soil, and the crops may suffer in seasons of prolonged drought. Unless properly handled, the soil tends to bake in hard clods, and to secure the best tilth possible it must be plowed when in the right condition of moisture. Disk plows are recommended, as the soil does not adhere to the mold board as in the case of a turning plow. After each rain a hard crust forms, necessitating frequent cultivations in order to prevent loss of moisture.

The rolling topography promotes good surface drainage, but the compact subsoil does not readily allow surface water to escape. This defect could easily be remedied by underdrainage. The shallow plowing practiced and the small amounts of organic matter contained in the soil tend to reduce its water-holding capacity and a shallow surface root system is developed, so that crops suffer more from drought than they would under better cultivation. Subsoiling, although not practiced, would be of great benefit, as would also the plowing under of cowpeas and green manures.

The Decatur clay loam is found mainly in Jones, Opossum, and Cahaba valleys, occurring next to the Conasauga clay and Huntington silt loam. On account of its nearness to Birmingham and its location on macadamized roads and railroads, it is becoming a favorite truck soil. Its heavy texture makes it especially suited to the growing of such crops as tomatoes and cabbage, whil cowpeas, garden peas, and sweet corn do very well.

This type is residual, being derived through the solution and filtration of the Coosa shales and Knox dolomite, which form the floor of the valleys above mentioned. As the rocks have only a small percentage of insoluble material, it is estimated that the solu-

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tion of several thousand feet of limestone was necessary to form the present depth of soil.

The Decatur clay loam was originally forested with a heavy growth of cedars, longleaf pine, and hardwoods. It was among the first soils farmed in the county, producing large yields of corn, wheat, and cotton, though the acreage of cotton was small. At present the type is utilized largely for market gardening.

As much of the type lies around Birmingham, where it will ultimately be used for building lots, it sells in excess of its agricultural value, bringing from $50 to $100 an acre.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of this type:

Mechanical analyses of Decatur clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
20244	Soil	1.3	3.5	3.8	12.1	11.4	46.6	21.0
20245	Subsoil	1.0	2.6	2.6	8.8	11.0	40.2	33.5

HAGERSTOWN STONY LOAM.

The Hagerstown stony loam to an average depth of 8 inches is a light-brown to reddish-yellow silt loam containing a variable quantity of small fragments of shale or impure limestone. The subsoil to a depth of 36 inches is a reddish-brown or reddish-yellow silt loam becoming slightly heavier with depth. It is often impossible to bore to a depth of 3 feet, owing to the quantity of rock fragments.

The type has a rather open, loose structure, and the stone content tends to promote aeration and drainage. It can be plowed when wetter than either the Hagerstown loam or the Decatur clay loam, as its tendency to clod and bake is not so marked. It does not gully so readily as some of the other types.

The Hagerstown stony loam is found in Jones, Cahaba, and Opossum valleys. It occurs on the foothills and often connects areas of Hagerstown loam with the Clarksville series. It is formed from the Knox dolomite and Coosa shale of Cambrian and Silurian age, and the rock fragments found in the soil are the less soluble remnants of these formations.

Where not under cultivation, the type supports a growth of scrub oak and shortleaf pine. It is well suited for pasture. Of the cultivated crops corn, and especially cotton, do very well, the former yielding from 15 to 20 bushels and the latter one-half bale to the acre. By the combined use of manure and fertilizer, together with the growing of cowpeas and deeper plowing, these yields could be greatly

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increased. On the southern and western slopes peaches and all fruits should do well.

Land of this character is valued at $15 to $50 an acre, depending on location and improvements.

The following table gives the average results of mechanical analyses of samples of the soil and subsoil of this type:

Mechanical analyses of Hagerstown stony loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
20260, 20262	Soil	1.5	6.2	5.1	9.3	6.2	57.4	14.6
20261, 20263	Subsoil	1.1	3.8	3.0	6.3	6.1	51.4	28.4

WABASH CLAY.

The Wabash clay is a very heavy black clay loam or clay with an average depth of 6 inches, underlain by a grayish-brown clay which becomes grayer to a depth of 36 inches.

The type consists mainly of alluvial material, with a slight admixture of colluvial material from adjacent soils. In times of high water it is mostly overflowed.

At present the Wabash clay is left in forest and used exclusively for pasture. If cleared and drained, it should produce good truck crops, such as cabbage, tomatoes, and sweet corn, for which there is a ready market in Birmingham.

Only a limited extent of the Wabash clay is found in the county, and as it occurs near the city it will probably be used mainly for factory and building sites.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of the Wabash clay:

Mechanical analyses of Wabash clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
20272	Soil	1.0	3.3	2.2	6.5	5.0	48.3	33.7
20273	Subsoil	1.3	2.6	1.6	5.4	4.8	50.0	34.2

CLARKSVILLE STONY LOAM.

The fine earth of the surface soil of the Clarksville stony loam is a light gray to whitish sandy or coarse silty loam. The soil has the whitish color when dry, and in that condition the material has a floury, ashy feel. With the soil is mingled a varying amount of sand and a large percentage of gravel consisting of angular chert

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fragments of a grayish color, or yellowish when stained by iron. The amount of cherty material upon the surface, where of the finer grades, varies from 20 per cent to possibly 50 per cent of the soil, while in places on ridges and slopes the accumulation is much greater. In such places there is little true soil, and the subsoil is reached at depths ranging from 5 to 35 inches. It is usually impossible to bore more than 20 inches on account of the abundance of chert.

As the Clarksville stony loam erodes very readily, it follows that the lower parts of all hillsides consist of soil derived in a large measure from higher lying areas through the agencies of washing and soil creep. Such areas often occur as a narrow grayish belt skirting a hill and are closely allied to the Clarksville gravelly loam, but it was impracticable to show such areas on a map of the scale used in the survey owing to their limited extent. In some low-lying areas where drainage is not good the subsoil may be gray and heavy with clay and silt, but as the type is generally well drained such areas are of infrequent occurrence.

This type of soil is very friable, does not bake, and can be plowed when quite wet. It is very easily eroded, however, and it often presents the appearance of a gullied waste. No effort is made to protect the land from erosion. On account of its rolling, hilly, or mountainous topography, open structure, shallow plowing, and great lack of humus, it does not retain water readily and suffers from drought as well as erosion.

The Clarksville stony loam is of residual origin, being derived through solution and disintegration from the Knox dolomite of Cambrian and Silurian age and also from Fort Payne chert of the lower Subcarboniferous age. The latter formation appears to be a dolomitic limestone with siliceous layers. Doubtless hundreds of feet of rock have been reduced in the making of 1 foot of soil. All traces of limestone have long since disappeared, only the siliceous silty material and flinty chert remaining.

Areas of this type of soil are located in the northeastern part of the county between Jones and Opossum valleys, ending in the mountain of Rough, stony land in the northern part.

The original forest growth was mostly longleaf pine. Where this has been removed it is replaced by a mixture of oaks, with some chestnut. Only the less stony areas are cultivated. Owing to its origin and high percentage of chert it is not naturally a productive soil, though when fertilized cotton yields from one-fifth to one-fourth bale per acre. Corn does not do so well, yielding from 10 to 15 bushels per acre.

To provide humus the growing and plowing under of leguminous crops is recommended. If cowpeas are sown in every crop of corn and cotton when it is laid by, the soil will soon be stocked with sufficient

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humus to make the use of commercial fertilizers more profitable. The incorporation of organic matter will also lessen erosion and increase the water-holding capacity of the soil. Land of this type of soil should be plowed from 8 to 10 inches deep.

Orchard culture is beginning to be practiced in the county, and the Clarksville stony loam is well adapted to fruit. In other Alabama counties this type successfully produces Elberta peaches and apples. At Birmingham Elberta peaches retail at from 15 to 30 cents a dozen, according to size and time of season. If given proper care and fertilization, fruit trees will succeed better than any other crop for which the soil could be used. The rougher areas, however, should be kept in forest.

In Lauderdale County the result of a single fertilization test made on this type of soil by the Alabama State Experiment Station and explained in Bulletin No. 145 of that station, shows that all fertilizers give profitable yields, but that phosphoric acid combined with cottonseed meal or some other nitrogen carrier gives the best results.

The following table gives the results of mechanical analyses of fine-earth samples of the soil and subsoil of this type:

Mechanical analyses of Clarksville stony loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
20242	Soil	5.8	11.2	4.9	9.9	8.4	50.9	8.9
20243	Subsoil	10.6	13.1	5.1	9.9	8.6	39.5	13.3

DEKALB SHALE LOAM.

The soil of the Dekalb shale loam, to a depth of about 8 inches, is a light-brown or, when dry, gray silt loam or loam of fine floury texture. Interspersed with the surface soil is from 30 to 60 per cent of flat shale chips a fraction of an inch thick.

From 8 to 30 inches the material is a very heavy silt or clay loam, tending to a clay where the parent rock is finer textured. It varies in color from a yellow to a light reddish or mottled gray, being mottled red and gray in low places where the drainage is not good. The amount of shale fragments in the subsoil increases with depth until it becomes a mass of disintegrated shale, through which it is usually impossible to bore.

Where the shale fragments are abundant the soil can be plowed when wet with little danger of baking. It seldom becomes lumpy except where the surface soil has been removed by erosion and fresh subsoil is plowed up. Owing to the light nature of the soil and the high percentage of shale particles that are slowly absorbent it does

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not take up water as rapidly as other soils and in consequence washes badly. It is not terraced, contains little humus, and is plowed very shallow, so that its absorptive capacity is limited and the crops are apt to suffer severely from drought. In places the material has the stratified appearance of rock, but it is so weathered that it crushes readily when bored. Where this type of subsoil prevails the soil is able to withstand drought better than elsewhere, because the soft, decomposed shale gives up water very slowly.

Owing to the hilly, rolling topography the Dekalb shale loam is well drained. In many cases it is the product of erosion, the finer material having been removed to lower levels, leaving behind the shale chips. On this account the type is found in the hilliest portions of the area and on the upland slopes. It consists of long, narrow ridges and valleys or rounded knolls, and is largely developed in the northern and western portions of the county.

The Dekalb shale loam is derived from the weathering of fine-grained rocks of the Coal Measures. These may be seen outcropping along the roads where erosion has been quite active. They vary somewhat in texture and give rise to some variation in the soil. As a result of this occasional areas are sandier than is typical. It is usually found in such areas that the amount of shale chips is less.

The virgin forests consisted largely of longleaf pine and oaks. With the cutting of the pines, oaks have largely taken their place, and some of the type is being cut the second time. Much of this type is held by large corporations for the mineral rights and little attempt is made to farm the land. For this reason, and because of its hilly topography and distance from railroads, it is not thickly settled. Most of the farming is done by tenants on shares. The average yield of cotton is about one-third bale, and of corn about 10 bushels per acre.

If the soil were plowed a little deeper year by year and crops of cowpeas turned under, and if the fields were terraced and winter vetch or some other hardy annual were sowed in the fall to prevent washing, the best areas would produce profitable crops. It is not uncommon for thrifty gardeners to buy a small farm and by careful tillage pay for it with the proceeds of a sale of truck in two or three years.

From the fact that scuppernong and muscadine grapes grew profusely, it is probable that they and other varieties adapted to the climate would do well if given proper culture. The soil is strikingly similar in texture to some of the grape soils in New York State. Occasional apple trees seen were making a healthy growth, and orchards should do well.

The results of fertilizer tests made by the Alabama State experiment station 2 miles northwest of Tidwell on soil closely allied to this

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type indicate that the greatest profits follow the use of cotton seed and phosphate.

Exclusive of mineral rights land of this type of soil brings from $5 to $10 an acre, depending on improvements and location.

The following table gives the average results of mechanical analyses of samples of the soil and subsoil of this type:

Mechanical analyses of Dekalb shale loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
20250, 20252	Soil	3.0	4.9	1.6	2.8	7.7	59.7	20.4
20251, 20253	Subsoil	1.9	4.7	2.0	4.4	1.8	53.2	31.6

HAGERSTOWN LOAM.

The soil of the Hagerstown loam consists of 6 or 8 inches of a reddish-brown loam, containing a few stones and iron concretions. It has a looser and more open structure than the Decatur loam, but is heavy enough to puddle and bake if plowed too wet. The subsoil to a depth of 20 inches is a heavy red crumbly silt loam, grading into a clay loam at 36 inches. This material may be many or a few feet deep, owing to the irregularity with which the limestone rock dissolves. In some places, notably north of Birmingham, the Coosa shales outcrop. With this exception, the type is not stony.

Owing to its level and gently rolling topography, the type does not erode badly except on knolls, where "galled spots" are a conspicuous feature. The type is usually well drained, except in a few low areas where it joins the Conasauga clay. The drainage is also good, as is indicated by the uniform weathering to a solid yellowish red. In a few instances, where the subsoil is mottled or gray, imperfect drainage is shown.

In origin the Hagerstown loam is a residual soil. It is derived through decomposition and filtration from the Knox dolomite and Coosa shales formations. The more soluble parts of the limestone have largely disappeared, leaving only the insoluble residue to make the present soil.

Originally the Hagerstown loam was heavily forested, chiefly with cedars, pine, and a few oaks. On the limestone outcrops cedars now grow, but the second growth is largely oak. At present unfarmed areas grow up thickly with dog fennel, and the bottom land is covered with a thick growth of Japan clover, which furnishes good pasture.

As the soil is naturally deep and well drained and grows clover profusely, there is no doubt that alfalfa would do well, and if inoculated, fertilized, and kept sweet with lime there is no reason why the crop should not prove profitable.

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It is common practice to plow the soil in the fall in order to improve the physical condition. It would be a good plan to sow oats or winter vetch as a winter cover crop, to prevent leaching and to lessen erosion. As upon other types, no regular rotation of crops is followed on the Hagerstown loam. The soil, however, is better supplied with humus than many others, because of the custom of sowing cowpeas or peanuts in the corn. Some stable manure is used. This is obtained from Birmingham, near which city the type is developed.

Some farmers are beginning to use the disk plow. This is superior in some ways to the ordinary turning plow, although the 2-horse turning plow cuts a deeper furrow.

In farming this type of soil, the use of commercial fertilizers is general. A mixture analyzing 10–2–2 is commonly used, but, whatever the ratio, the proportion of phosphoric acid is always high. The fertilizers are used with little regard to the specific needs of the crop to be grown or of the individual field. If each farmer would make careful tests of the different brands, there is little doubt he would be able to determine upon a course of treatment that would greatly increase crop yields. Home-mixed fertilizers have proved profitable in some areas, a saving in the cost of materials adding to the net gains.

Before the war the Hagerstown loam was largely under cultivation and was recognized as a strong soil. At present corn yields 15 to 25 bushels and cotton one-third to one-half bale per acre, depending on the care in cultivation. Oats produce 15 to 20 bushels per acre, cowpeas about the same, peanuts 50 to 75 bushels, and tomatoes 75 to 150 bushels.

Farms composed of this type of soil bring from $75 to $100 an acre, the price varying with location and the character of improvements. Near Birmingham its value is too high to warrant use in the production of general farm crops.

The following table gives the average results of mechanical analyses of fine-earth samples of the soil and subsoil of this type:

Mechanical analyses of Hagerstown loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
20258	Soil	0.3	2.9	2.3	11.7	24.8	42.3	15.9
20259	Subsoil	1.4	1.9	1.5	7.0	15.9	39.5	33.1

ROUGH STONY LAND.

The Rough stony land comprises those portions of the area which are so rough and stony as to prohibit cultivation. In most cases the topography is so uneven as to make farming unprofitable because of

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the tendency to excessive erosion and the difficulty of carrying on farm operations. Many large bowlders lie half buried in the soil, and the removal of most of these will probably not be accomplished until land values have greatly increased.

The areas mapped as Rough stony land should by no means be considered valueless; there are many small areas of an acre or less that can be farmed successfully, while nearly all of it may be utilized for pasturage.

On the limestone areas cedars grow abundantly and on other areas other trees grow luxuriantly. The type should be kept as far as practicable in forest, and under proper management profitable yields of lumber could be secured. In some instances valuable quarries of limestone and chert have been opened. The type has a low agricultural value, being held mainly for its mineral or timber rights.

ROCK OUTCROP.

Owing to the displacement of the strata before mentioned it happens that the more resistant rock will often resist weathering and be left as Rock outcrop. Such places have, whenever possible, been indicated by symbols, and usually occur in the form of narrow strips suited only for forestry.

SUMMARY.

The Jefferson County area lies in the north-central part of the State of Alabama and comprises 719,360 acres, or 1,124 square miles. It is the seat of the most extensive coal, iron, and limestone deposits in the South.

The county has two main topographic divisions—the Cahaba Valley and the valleys of Jones and Opossum creeks, and the much dissected upland to the north and west of these valleys. The elevation varies from less than 240 to 1,400 feet, with an average of 500 to 800 feet above sea.

The important rivers are Little Cahaba, Warrior, and Locust Fork.

Transportation facilities are good. In addition to nine main railroads there is an excellent system of macadamized roads.

The principal cities and towns are Birmingham, with its numerous suburbs, and Bessemer, Ensley, Leeds, Trussville, and Warrior.

The climate is exceptionally mild and favorable to a wide variety of staple and special crops. Snow is rare, and freezing weather seldom lasts for more than a few days each winter. The rainfall is ample for crop growth and generally well distributed throughout the year.

Industrial development has stimulated trucking and general produce farming. The staple crops in general are corn and cotton with some forage crops. Dairying interests are being extended.

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Farm labor is chiefly colored and is well paid owing to competition with the mines and other industrial enterprises.

Deeper plowing and more frequent tillage should be practiced.

Winter cover crops should be sown on all cotton and corn fields in order to prevent erosion and leaching, and at the same time to add humus to the soil.

Systematic rotation should be introduced.

More hogs and farm stock should be kept. Goats and sheep will do well in forested portions and on nonagricultural land.

Thirteen soil types representing eight series were mapped in the county. As regards manner of formation these soils are of two broad classes, namely, alluvial and residual.

The alluvial soils are the Wabash clay, Huntington gravelly loam, and Huntington silt loam. The first two are important soils, but of limited extent. The last named is a very strong soil and is a favorite for the growing of corn and truck.

The residual limestone soils include the Decatur clay loam, Hagerstown stony loam, Hagerstown loam, and the Clarksville stony loam.

The Decatur clay loam is a strong soil, but the bulk of the type is located close to growing cities, and is held at high prices for building sites. It is naturally suited to a wide range of crops, and with careful tillage and the use of manures can be profitably used for trucking.

The Hagerstown stony loam is well adapted to fruit growing and to the usual farm crops.

The Hagerstown loam is a good general farming soil and its use for market gardening is increasing.

The Clarksville stony loam is the best soil for the growing of tree and bush fruits. Systematic orcharding would be very profitable here.

The Dekalb shale loam, residual from shale, occurs in the rougher upland country. Hillside areas have many of the physical characteristics of the grape soils of the Northern States. The famous scuppernong grape grows especially well on the hilly ridges and slopes. The type is susceptible of improvement and under modern methods is a profitable farming soil. Where the slope permits, Irish potatoes will succeed. It is better adapted to Irish than to sweet potatoes.

The Dekalb silt loam is of very wide extent and has certain variations of texture that make it a favorite for general farming and trucking. Market gardening will prove more profitable on this type than any other form of agriculture.

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SOIL SURVEY OF HOLMES COUNTY, MISSISSIPPI.

By W. J. GEIB.

DESCRIPTION OF THE AREA.

Holmes County is situated a little northwest of the center of the State of Mississippi, and comprises an area of 524,992 acres, or about 820 square miles. It lies wholly within the Mississippi Basin, and the drainage is effected by the Yazoo and Big Black rivers. It is bounded on the north by Carroll County; on the east by the Big Black River, which divides it from Attala and Madison counties; on the south by Yazoo County; and on the west by the Yazoo River, which separates it from Washington and Leflore counties.

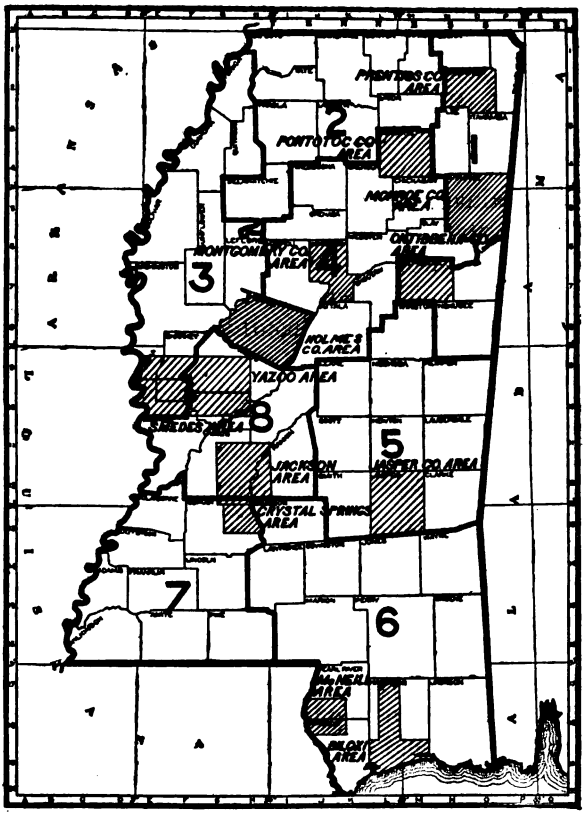

FIG. 19.—Sketch map showing location of the Holmes County area, Mississippi.

The surface of the county may be divided into two physiographic divisions, one known as the "Delta" and the other as the "Hill Section." The dividing line between these divisions consists of a line of bluffs extending from Memphis to Baton Rouge in a long, flat arc, and this escarpment forms the eastern boundary of the Mississippi Delta. The bluffs rise from 75 to 200 feet above the level of the Delta, and in many places the walls are nearly perpendicular, while in others the descent is a steep slope or a more gentle decline.

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The hill section comprises the eastern two-thirds of the country and is characterized by a topography varying from rough and broken to gently rolling and nearly level. The greater part of the upland is rolling and hilly. In the vicinity of Franklin and Richland and south to the county line the surface is only gently rolling, while along Black River it is nearly level, although sloping gently toward the lowland bordering that stream. The loess covering this entire region has been badly eroded in many places, and large tracts have thus been rendered unfit for cultivation.

The eastern part of the hill section drains into the Big Black River, which forms the eastern boundary of the county, and, flowing in a southeasterly direction, empties into the Mississippi River about 20 miles below Vicksburg. The western part of this region is drained by Little Black Creek, which receives the waters from Fannegusha, Harland, and Willis creeks, and then flows into Tchula Lake, through which it connects with the Yazoo River. The divide between these two drainage systems enters the county about 7 miles northwest of West, a station on the Illinois Central Railroad. It extends south to a point 3 miles east of Bowling Green, turns southwest to within 2 miles of Franklin, whence it swings due west for about 6 miles, after which it again extends southward, leaving the county 4 miles southwest of Ebenezer.

The western one-third of the county comprises a part of the Mississippi flood plain known as the "Yazoo-Mississippi Delta." It consists of a low, flat alluvial bottom with an elevation above sea level of about 115 feet. The variation in elevation within this part of the Delta is from 10 to 20 feet. The drainage system consists of winding streams, long, narrow, crooked lakes, and numerous bayous. These lakes represent old stream channels which were abandoned by the streams when in times of high water new channels were formed. Tchula Lake, which is the longest of these, connects with the Yazoo River at Marksville, extends in a southerly direction and again joins the same stream about 15 miles below. This course forms Honey Island. The old channel curves in broad arcs and bends back upon itself, forming many large and small peninsulas. In tracing its course through all of its windings the entire length is nearly 35 miles, but in a straight line the distance is about 15 miles only. Horseshoe and Bee lakes are similar in character, although smaller in extent. Both of these connect with Tchula Lake.

The earliest permanent settlements within the present county limits were made between 1826 and 1836. The present inhabitants are nearly all descendants of settlers who came from the Carolinas, Georgia, Virginia, Kentucky, and Tennessee. A few people from more northern States have come in to engage in the lumber business or to practice general farming or trucking. In 1900 there were 8,120

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whites and 28,708 negroes in the county. In the hills the races are about equally divided, but in the Delta the blacks are by far the more numerous.

Holmes County was organized February 19, 1833. It was originally part of the territory forming the large county of Hinds, ceded to the United States by the Choctaw Indians in the treaty of Doak's Stand, October 18, 1820, and was long known as the "New Purchase." One of the counties created out of Hinds was Yazoo County, from which was taken the territory forming the present county of Holmes.

The county seat is located at Lexington, near the center of the county, on a branch of the Yazoo and Mississippi Valley Railroad, which extends from Durant to Tchula. It is a prosperous town of 2,000 inhabitants, has a cotton compress, oil mill, and gin, and is the leading cotton market in the area. It has four banks, an electric-lighting plant, numerous business houses, and is well supplied with artesian water. Durant, with a population of 2,300, is located in the eastern part of the county, on the main line of the Illinois Central Railroad. It has a wagon factory, brick plant, canning factory, electric lighting plant, two banks, and numerous business houses. It also is well supplied with artesian water. Large quantities of strawberries, potatoes, and cabbages are shipped to northern markets from this point. Three miles west of Durant is Castalian Springs, which has gained a reputation because of the healthful properties of its mineral water, and has become a summer resort of considerable importance. Cruger, Tchula, Mileston, Thornton, Beelake, West, Goodman, and Pickens are small railroad towns of less importance.

The transportation facilities are excellent. The Yazoo River on the west furnishes water transportation for the part of the delta bordering that stream. The main line of the Illinois Central and a branch extending from Grenada to Jackson, by way of Greenwood, traverse the area from north to south. These lines are connected by a branch road running from Tchula to Durant. Another line extends from Durant to Aberdeen, Miss. Durant is 680 miles south of Chicago and 242 miles north of New Orleans.

Cotton is bought at all of the towns within the county and these places furnish a limited market for dairy products, vegetables, and the like. Practically all of the small fruits and vegetables shipped north are consigned to Chicago. The dirt roads throughout the county are worked by contract and are usually in fair condition. During the winter in the delta they are very bad, and it is almost impossible to travel over them. In the summer they become as hard and firm as pavement.

CLIMATE.

As the Weather Bureau has no station in Holmes County it is necessary to refer to the records from the nearest outside station, which

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is located at Yazoo City, Miss. As this is but 12 miles from the south boundary line of the area, the data will apply very well to this section. The following table gives the normal monthly and annual temperature and precipitation as recorded at the Yazoo City station:

Normal monthly, seasonal, and annual temperature and precipitation.

Month.	Temperature.			Precipitation.			
	Mean.	Absolute maximum	Absolute minimum.	Mean.	Total amount for the driest year.	Total amount for the wettest year.	Snow, average depth.
	°F.	°F.	°F.	In.	In.	In.	In.
December	47	82	9	4.2	0.6	4.6	0.2
January	46	81	10	5.5	3.8	7.5	.7
February	45	82	−2	4.8	8.7	3.2	1.2
Winter	46	.....	.....	14.5	13.1	15.3	2.1
March	58	91	24	5.9	3.6	6.0	Trace.
April	66	96	33	4.2	3.5	11.2	.0
May	75	103	42	3.0	2.0	2.3	.0
Spring	66	.....	.....	13.1	9.1	19.5	Trace.
June	80	102	48	4.5	3.1	5.8	.0
July	83	107	51	4.4	.6	7.6	.0
August	83	107	52	4.4	1.7	7.4	.0
Summer	82	.....	.....	13.3	5.4	20.8	.0
September	76	105	39	2.6	.6	2.1	.0
October	65	99	24	1.8	4.5	.3	.0
November	55	88	14	2.8	2.6	4.8	.0
Fall	65	.....	.....	7.2	7.7	7.2	.0
Year	65	107	−2	48.1	35.3	62.8	2.1

The table shows a maximum temperature of 107° and a minimum of −2°, or a range of 109°. The mean annual temperature is 65°. The hottest months are July and August, while the coldest are January and February. The mean for the delta is slightly lower than in the hills, but the difference is not marked.

The rainfall for the series of years given varies from 35.3 inches to 62.8 inches, with a mean of 48.1 inches. As will be seen, it is fairly well distributed throughout the year, the least rainfall being during the cotton-picking season of September, October, and November. Rain frequently comes in torrents, causing considerable damage to the uplands by washing and erosion and to the lowlands by flooding. Late floods frequently overflow the bottoms and portions of the delta, and do considerable damage to growing crops, necessitating the replanting of cotton and corn.

The winters are mild, but the weather is very changeable. The summers are long and warm. Spring opens in March, and the season is so long that two crops can readily be grown upon the same field.

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The average date of the last killing frost in the spring is March 27, and the average date of the first in the fall is November 2. The date of the latest killing frost on record is April 21, and the date of the earliest in the fall is October 21.

AGRICULTURE.

The first farms in Holmes County were cleared between 1826 and 1836, and the four earliest settlements were Rankin, Montgomery, Vernon, and Georgeville, all now extinct. Before the war large plantations were in operation in various parts of the county. These were practically self-supporting. Everything consumed at home, except a few luxuries like tea and coffee, was grown upon the plantation. Even the common wearing apparel and shoes were made at home. Cotton was the only money crop, and as there were no railroads it was necessary to haul this staple to points on the Yazoo River, from which it was shipped by boat. Some hauling was also done between this section of the State and Jackson, as railroads were constructed to that point before any reached Holmes County. Besides cotton and corn, some wheat, oats, and a little tobacco were grown, and enough beef and pork were produced to supply the domestic needs.

The farm implements and methods were very crude. In the eastern part of the county the farm operations were at first confined to the uplands because of the comparative ease with which the hills were cleared and made ready for the plow, but later the bottoms along the streams were cleared, and found to be very productive. The system of cultivating the hill land was careless and wasteful, especially upon the large plantations, where, as soon as the soil ceased to yield well, fields were abandoned and allowed to wash and gully, and new clearings were made, which in turn were abandoned after a few years of use.

In the delta section only a few plantations were in operation prior to 1850. These were located along the front lands bordering the Yazoo River and Tchula Lake. The tracts containing the sandy ridges were usually selected first, as this land was easy to cultivate and less frequently inundated than the heavy low-lying soils of the interior. The soils of the delta were more productive than the hill lands, and fields were seldom if ever abandoned as "worn out." Several of the old plantations have been growing cotton continuously for over sixty years, and still produce profitable yields.

With the coming of the railroad to this region the production of wheat and tobacco was greatly reduced and finally discontinued, and for many years, as is still the case, not enough corn and hay have been grown to supply the local demand. Cotton has been the

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money crop and success in farming has depended upon this one staple.

From the civil war to within twelve or fifteen years ago the agriculture of the area was nonprogressive. There had been few improvements in the implements used, in the care of the soil, or in the growing of crops. The low price of cotton for many years discouraged a considerable number of the farmers, and some moved to what they considered more prosperous sections in other States. The agricultural practices are now in a transitory state. Cotton is still the chief money crop, and more attention is given to it than to all other crops, but the farmers are coming to realize that it is more profitable to reduce the acreage of cotton, to grow more corn, oats, and cowpeas, and to practice some definite crop rotation. Some of the farm implements still in use are crude, but great advances are being made along this line, and now the disk harrow, disk plow, two-horse turning plows, and two-horse cultivators are not uncommon.

When preparing land in cotton one year for cotton the next year, the general custom is to turn two furrows together between the old rows, and later to run a lister under the row itself, throwing the dirt into the middle of the rows and making a low ridge. This may be run over with a one-horse cultivator to improve the seed bed, or the seed may be planted without further preparation. Ordinary one-horse cotton planters are used to sow and cover the seed. The after cultivation given to the crop is not usually sufficient to regulate the moisture supply and give the best possible results.

The cotton grown is principally the short-staple varieties, though there are quite a number of planters who each year cultivate a small acreage of long-staple cotton. It is usually more profitable to grow short-staple cotton, as there is not always a market for long staple and the yields are smaller, and these factors about compensate for the higher price.

Not as much corn is grown in the area as should be, the production not equaling the local demand, and each year considerable corn is shipped in and sold to farmers throughout the county. More thorough cultivation on the present acreage would do much to meet this deficiency. Attention to the selection of seed is an important factor in successful corn growing, and care in this detail will well repay the planter. A corn club, which has been recently organized, is giving this matter attention, and marked results have already been obtained.

Oats are grown to a limited extent and may be seeded either in the spring or fall, though the fall seeding seems to give the best results. None of the grain is thrashed, the crop being cut and cured for hay. All of the oats fed to stock as grain are shipped in. There is no reason why this crop should not be more extensively grown.

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Cowpeas have a greater acreage than formerly, and their use is becoming more popular each year. The most progressive planters sow cowpeas in the corn at the last cultivation. After the corn is gathered the vines are pastured or plowed under. They greatly improve the soil, and the cotton the following year plainly shows marked soil improvement. Cowpeas are also sown for hay, and the vines when cured are greatly relished by stock.

Sugar cane is grown in the creek bottoms throughout the hill portion of the county and also in the delta. The molasses brings a fair price in the local market, and practically the entire output is consumed within the area.

In the vicinity of Durant the trucking industry has been developed to considerable proportions. Strawberries, cabbage, Irish and sweet potatoes, peas, and beans are profitably grown. Strawberries are sometimes ready for the market by the middle of March, although the season may vary as much as two or three weeks. The berries are packed in crates of 24 quarts each and shipped in refrigerator cars. Cabbage is started in cold frames and transplanted to the field from the first to the middle of March. Irish potatoes are planted about the same time. The potatoes are ready for market anywhere from the first to the middle of June, and the cabbage not much later.

Practically all of the berries, cabbage, and potatoes are shipped to Chicago. In 1907, 43 carloads of strawberries, 7 cars of cabbage, and 1 car of Irish potatoes were shipped from this point. Considerable quantities go in less than car lots. Buyers come to the area to purchase strawberries; the rest of the truck is shipped to commission houses. There is a local truck growers' association formed to aid in intelligent marketing of the produce.

The season is of sufficient length so that two crops of potatoes, a crop of cabbage and a crop of potatoes, or early potatoes or cabbage followed by cotton can be grown upon the same field. The returns from these crops have been very encouraging and the trucking industry is being extended. The acreage devoted to cabbage is being greatly increased this year.

The live stock of the area is mostly of inferior grades. With cattle, Jersey blood predominates and there are some thoroughbreds.

The local meat markets are supplied with beef from home-grown cattle, and some beef cattle are shipped out each year, but these are usually small and not in prime condition, and therefore the price obtained is low. The dairy industry has not been developed to any extent, there being but one first-class dairy in the county. This industry could be profitably extended and should be encouraged. Some hogs are kept on every plantation, but they are not extensively raised, and large quantities of pork are shipped in from the large

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packing houses. It would seem that hog raising could be made very profitable here.

The question of winter forage crops for this section of country is an important one and should be carefully considered by all who expect to raise stock. For the maintenance of a dairy herd or for the production of beef or pork it is desirable to have some forage crops which can be cut and fed to the stock or used as a pasture crop at any time of the year. A continuous supply of succulent feed will greatly increase the flow of milk and reduce the expense of producing beef and pork. Oats, rye, or barley, if sown in the early fall, make a good pasture for late fall and winter. Turf oats and vetch, if sown in October or November, give good pasture for two or three months during the winter. Cowpeas can be readily grown and cut and fed green or cured for hay. Alfalfa when once well established furnishes excellent pasturage and yields a large return of hay. Rape is also a crop which should be grown more in this section. It should be sown in September or October. Corn and sorghum should also be used for soiling crops, and Bermuda grass and Japan clover can be utilized for summer pasture.

The question of fertilizers is now receiving more attention than formerly, and within the last few years some of the leading planters have been trying commercial fertilizers. Their use, however, is not common. Tests of different kinds of fertilizers should be made by the farmers throughout the hill section of the country to determine the peculiar needs of the several soils. The Mississippi experiment station has done valuable work along this line, and the reader is referred to bulletins of that station for more detailed information.

In the trucking section about Durant, commercial fertilizers are used more freely than elsewhere in the county. For potatoes and cabbage the following home mixture is sometimes used: 1,300 pounds cotton-seed meal and 700 pounds of acid phosphate applied at the rate of 250 to 500 pounds per acre. Ready prepared fertilizers are also used. There seems to be a doubt among some of the growers as to the benefit of commercial fertilizers for strawberries, but as remarkable results have been obtained in other places by using fertilizers, it would seem that their judicious use here would also be profitable. The use of nitrate of soda at the rate of 200 pounds per acre, applied preferably at intervals during the growing season, should greatly increase the yield. Where stable manure is used it has been found advisable to supplement it with wood ashes or muriate of potash.

No systematic crop rotation is practiced in the area and comparatively little attention is given to the adaptability of the various soils to particular crops. Some fields have produced cotton for over sixty years. A systematic crop rotation, together with proper culti-

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vation, would not only increase the productivity of the soil, but it would materially lessen the damage done by washing. If cotton and corn are to be grown as the main crops, a 2-year rotation with these alternating can be profitably followed, provided catch crops be grown. At the last cultivation of corn, for instance, cowpeas should be sown and a winter cover crop to be pastured or turned under may be sown later. This will greatly increase the productiveness of the soil. A 4-year rotation may be had by adding oats one year and then allowing the field to grow up to grass one year. Oats should be sown in the fall and plowing for the corn crop should also be done in the fall or winter. The soil should be plowed to a depth of 7 to 9 inches and very thoroughly pulverized before the seed is planted.

Holmes County is distinctly divided into two cotton regions. In the upland country the farms are smaller than in the delta and more generally cultivated by their owners. The cotton from this section is all shipped by rail. In the uplands a single gin usually handles the crop of an entire community, while in the delta nearly all of the large plantations have gins of their own, and along the Yazoo River the cotton is shipped by boat.

The county has an area of 524,992 acres. The census of 1900 states that there are 359,859 acres in farms, of which 203,480 acres are improved. The size of landholdings in the area at present ranges from 20 to 5,000 acres. The average size of farms as given by the last census is 69.9 acres, but this is too small, as each tenancy was tabulated as a farm. The average individual holding is probably several times as great.

The large plantations are divided into small tracts, or "cuts," which are all under the supervision of a manager, but are farmed by colored tenants. Two systems of renting are practised. Under the share system the landowner furnishes everything except the labor, and gets half the crop. The owner has the first lien on the crop, and the merchant who supplies provisions has a second lien. The tenant may secure good returns for his labor or he may find himself in debt at the end of the season, according as the crop flourishes and as the prices rule high or low. In case a tenant has stock and tools of his own he may pay cash rent or give a stipulated quantity of cotton as rent. In the delta the rent varies from $4 to $9 an acre or from 50 to 80 pounds of lint cotton per acre. In the hills the rent is somewhat lower.

Day labor is somewhat more difficult to obtain than tenant labor, as much of the floating labor usually prefers to work in sawmills or on the railroad where wages are higher. The daily wage on the plantations varies from 50 cents to $1. No difficulty has been experienced in securing help to pick strawberries, women and children

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being employed. Two cents a quart is the usual price for picking berries.

Land values vary greatly in different parts of the country. In the vicinity of Durant, where trucking has been developed, some farms have been sold as high as $150 an acre. The farms throughout the uplands range from $5 to $40 an acre with an average of $15 or $20 an acre. In the delta for a good plantation about half under cultivation and well located $35 an acre is considered an average price. Large tracts in the open swamp may be bought for $8 to $15 an acre, depending upon the value of the timber. The plantations on the railroad, which are nearly all cleared, are often valued as high as $50 or $60 an acre.

Throughout the delta artesian water can be readily secured at a depth of from 750 to 900 feet, and throughout the hills it can be obtained at a depth of 900 to 1,100 feet.

Taking a general view of the agriculture of the country, too much dependence is placed on a single crop, cotton; too little attention is paid to the production of hay, corn, oats, and such other products as must be fed on the farms. The system of cultivation practiced at the present time tends to "wear out" the soil rather than to build it up, and the number of live stock is far below what it should be. The dairy industry and the production of pork should be extended, and more attention should be given to the growing of forage crops. Truck growing can be profitably developed along the railroad lines. A systematic crop rotation should be followed, deeper plowing and more frequent after cultivation should be practiced, and an attempt should be made to incorporate more organic matter in the soil.

SOILS.

Practically all of the State of Mississippi lies within that physiographic division of the United States known as the "Gulf Coastal Plain." The entire region was at one time occupied by an extension of the Gulf of Mexico. As the floor of this extension rose above the level of the sea, the various agencies at work produced marked differences in the surface features of the new land. The accumulation of vast deposits of marine shells give rise to the Selma chalk formation, from which the soil of the "black prairies" is derived. The deposition of materials stained with iron which were washed into the retreating gulf from the north and east gave rise to the Lafayette formation, from which are derived the soils of the oak and pine hills and pine flats regions. The very fine particles carried to this region, either by wind or water, or perhaps both, and deposited as a narrow band extending across the State from north to south, makes up what is called loess, forming the bluffs or "cane hills." The por-

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tion of the State which has been worked over and deposited by the Mississippi River and its tributaries is known as the Delta.

Three of the formations above referred to are represented in Holmes County, and each gives rise to soils having peculiar characteristics by which they can be readily recognized.

The oldest geological formation represented within the area is the Lignitic stage of the Eocene. This forms the floor upon which the later formations have been deposited. It consists of drab and bluish clays and frequently contains beds of lignite. These Eocene clays come to the surface in Holmes County only in a few places, where the overlying materials have been eroded, and as they do not influence the soils in any way, they need not be further considered.

Over the eastern two-thirds of the area the Eocene clays are covered to a depth of 4 to 20 feet by the Lafayette. This formation consists of red, yellow, and pinkish sands, clays, and gravel, and occurs very extensively throughout the Atlantic and Gulf coastal plains. From it are derived the Orangeburg and Norfolk series of soils. It is exposed in the present survey only along the foot of the bluffs, where it gives rise to the Norfolk gravelly loam, and in the eastern part of the area, where it forms the Orangeburg fine sandy loam. This latter type occupies the hillsides from which the loess has been eroded.

Directly over the Lafayette formation occurs the loess, which originally covered the entire surface of the area east of the bluffs to a depth of 4 to 30 feet. Erosion, however, has carried away much of this material until the underlying formation is now exposed in numerous places. The loess gives rise to two soil types, the Memphis silt loam and the Richmond silt loam.

The western one-third of the area is covered to a depth of 4 to 15 feet by alluvium, which has been deposited, reworked, and redeposited by the Mississippi River and its tributaries. This material is similar to that found throughout the flood plain of the great river and its branches.

The manner in which this important agricultural district was formed presents an interesting study. At one time the region was covered by an extension of the Gulf. Later the floor of this body of water gradually rose above the level of the sea. Rivers from the north brought down sediment and deposited it throughout the nearly level region at times of high water. Each successive overflow added new material, raising the land higher and higher above the mean level of the streams. This process has continued for centuries and is still going on. The result has been a wide area of nearly level land of great and inexhaustible productiveness.

The various soil types which have been recognized in the delta were deposited in standing or moving water, the speed of the current

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being the determining factor in the texture of the resulting soil. When the river overflowed its banks in times of floods there was a checking of the current as the water passed over the river banks. As the rate of the current was reduced the heaviest and coarsest particles held in suspension were deposited. These large particles accumulated from one flood to another until a low ridge was built up along the stream channel. Upon this ridge is found the Yazoo fine sandy loam, which represents the coarsest particles carried to this region by the stream currents. As the flood waters spread out over the country adjacent to the river the current was still further reduced, and as a result finer particles were deposited. These finer grains gave rise to a finer and heavier soil, which has been called Yazoo loam. The flood waters, after breaking over the banks and spreading over the adjacent lowlands, finally come to rest in the large interstream areas. While in a quiet state the finest particles held in suspension were deposited, and from this material has resulted the Wabash clay and the Sharkey clay.

Where the delta borders the bluffs there has been a wash from the high land to the low, the fine particles of loess accumulating near the foot of the bluffs, giving rise to two soil types—the Lintonia loam and the Waverly silt loam. A similar condition exists along the streams throughout the upland, but here only the Lintonia loam is found

Immediately at the foot of the bluffs, just below the loess, the Lafayette formation is frequently exposed. As the sand, gravel, and clay of this formation are gradually worked down by the elements, the type Norfolk gravelly loam is formed. The particles composing this soil are coarser and heavier than those of the loess, and consequently they are not carried any distance from the bluffs.

The Meadow areas are low, flat stretches along the streams of the upland, where the soil material has been much mixed in process of formation. The Meadow is subject to overflow and frequently remains in a swampy condition for the greater part of the year.

The following table gives the total area and relative extent of each type mapped:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Memphis silt loam	220,288	42.0	Waverly silt loam	8,512	1.6
Sharkey clay	102,080	19.5	Yazoo fine sandy loam	5,888	1.1
Richland silt loam	61,824	11.8	Orangeburg fine sandy loam	4,800	.9
Yazoo loam	31,488	6.0	Norfolk gravelly loam	1,792	.3
Lintonia loam	30,016	5.7	Total	524,992	.....
Meadow	29,760	5.7			
Wabash clay	28,544	5.4			

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YAZOO FINE SANDY LOAM.

The surface soil of the Yazoo fine sandy loam consists of a brown or light-brown fine sandy loam extending to a depth of 8 to 12 inches. The material is very uniform and consists almost entirely of very fine sand and silt, the two in the sample analyzed amounting to over 90 per cent. The silt content increases along the boundary of the heavier types, and here the soil has a loamy character. The subsoil consists of a compact brown fine sandy loam grading into a heavy loam at a depth of 16 to 24 inches, at which depth a clay loam of bluish color is often encountered. Along the highest part of some of the sandy ridges and along some of the streams the soil consists of a light fine sandy loam, underlain by a fine sand. This phase, however, is of small extent and was therefore not mapped as a separate type.

On account of the sandy nature of the soil, this type is more easily cultivated than any other in the delta and as a consequence is usually preferred.

The Yazoo fine sandy loam is confined to the delta and occurs chiefly as long, low, narrow ridges along the streams and old stream channels. The highest ridges along the streams seldom rise more than 8 or 12 feet above the general level of the delta. They form the front lands and slope gently toward the large inter-stream areas, as well as toward the streams along which they occur. In going down the incline into the interior, the soil grades from the fine sandy loam through a loam into a heavy waxy clay. Going toward the stream the fine sandy loam often extends to the water's edge, though there is frequently a narrow strip of loam or clay intervening.

Owing to the elevation and the sandy nature of the type the natural drainage is good, and, moreover, while a large part of the delta is submerged each year by floods, this type is never completely flooded, and only in times of the most general inundation is any part of it covered with water.

The Yazoo fine sandy loam is of alluvial origin. In times of floods the coarser particles held in suspension were deposited close to the margin of the streams, while the fine particles did not settle to the bottom until the current became less strong or until the stream came to rest in the low flat areas. These coarser particles—they are really comparatively fine—are the material forming this type of soil. The individual particles consist of quartz sand and mica, with a mixture of silt and clay.

Practically all of the type is under cultivation. Some of it has been tilled for over seventy years and most of the old plantations consisted partly of this type. From its earliest settlement cotton has been the chief crop, although some corn and cowpeas are grown. No fertilizers

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of any kind are applied and the yields have gradually decreased. Cotton yields from one-quarter to three-quarters bale per acre, with an average of one-third bale. Corn averages about 20 bushels per acre.

This type is adapted to a variety of crops and could easily be made to produce much larger yields by rotating crops and fertilizing. Cotton should be greatly reduced in acreage, and more corn, oats, and cowpeas produced. Alfalfa could also be grown successfully, and near the railroad early truck crops could be grown with profit. Cabbage, potatoes, strawberries, and tomatoes will do well and give good returns.

Farms of this type of soil range in value from $10 to $40 an acre, depending upon the location and improvements.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of this type:

Mechanical analyses of Yazoo fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18407	Soil	0.0	0.4	0.4	1.9	45.1	46.1	5.7
18408	Subsoil	.0	.1	.3	2.0	41.4	45.0	12.0

YAZOO LOAM.

The soil of the Yazoo loam consists of a fine, brown or nearly black heavy loam extending to a depth of 6 to 10 inches. The smooth feel, which is quite characteristic of the type, is due to the presence of a high percentage of silt. When the moisture conditions are favorable, the soil is easily cultivated and works into a mellow seed bed. When wet it becomes quite sticky. The subsoil consists of a drab or sometimes a mottled clay loam or clay which frequently becomes waxy. This extends to a depth of more than 36 inches.

The Yazoo loam is confined entirely to the delta and is always found near streams or old stream channels. It usually occurs as long bands varying in width from one-eighth to three-quarters of a mile, although a few irregular areas were mapped. The largest occurrences are found along Tchula Lake, Horsehoe Lake, and Bee Lake. These are old stream channels. The areas of this type of soil along the Yazoo River are not nearly as extensive as along the old stream channels.

As a type the Yazoo loam is a gradation from the fine sandy loam of the low ridges along the streams to the heavy clays of the interior. The surface has a very gentle slope toward the large interstream

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areas, and this results in fair drainage, the conditions being much better than in the case of the heavy clay soils, but not as good as with the Yazoo fine sandy loam.

The lower portions of the type are subject to overflow, but the surface water runs off as soon as the floods subside. With the installment of tile drains and more open ditches this soil will be greatly improved.

The Yazoo loam is an alluvial soil laid down by moving water, the current of which had been retarded to a greater extent than when the sandy ridges were formed.

The greater proportion of this type is under cultivation at the present time. It is considered the best all around soil in the delta, yet while it is a good general farming soil, cotton and corn are the only crops grown to any extent. Cowpeas are sometimes sown in the cornfields after the last cultivation, but this practice is not as common as it should be. No systematic crop rotation is practiced. The type is well adapted to grass, and on the higher, well-drained parts alfalfa will grow vigorously. Oats would also do well, and this crop should be grown more extensively. More cowpeas should be grown, and commercial fertilizers, which are not used at all at present, could be applied to great advantage. Commercial fertilizers, consisting chiefly of potash and phosphoric acid, should be used.

The methods of cultivation are similar to those in vogue throughout the delta. The land is plowed with a turning plow and later bedded with a lister. Frequently the turning plow is dispensed with. Level cultivation is followed to some extent, though this practice is not common, on account of the excess of moisture in the ground in the spring. Level cultivation is preferable when the drainage will permit.

The average yield of cotton is one-half bale, although 1 bale is often secured. Thirty-five bushels of corn is considered an average crop. Farms of this type of soil range in value from $15 to $50 an acre, depending upon the location and improvements.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of this type:

Mechanical analyses of Yazoo loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18411, 18413	Soil	2.1	3.8	1.4	3.2	9.7	56.9	23.1
18412	Subsoil	1.1	3.9	1.3	2.7	9.5	65.3	16.5

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WABASH CLAY.

The soil of the Wabash clay consists of 6 to 8 inches of black or dark-brown heavy clay loam. This is underlain by a drab or bluish waxy clay extending to a depth of more than 36 inches. The surface soil is stiff and waxy when wet. On drying the soil particles are drawn closer together, forming large and small compact masses and cracking the surface. The cracks are frequently 1½ inches wide and over 1 foot deep, and if close together the soil sometimes crumbles so as to present a pebbly or sandy appearance. On account of the color and size of some of these clay masses the term "buckshot land" is used in describing this soil.

Cultivation of the Wabash clay is difficult. If plowed when the moisture conditions are favorable, the soil becomes quite loose and friable during after cultivation. If plowed when too dry, large clods result and these are very difficult to pulverize, while if plowed too wet the heavy clay sinks back into the furrow in a compact mass and on drying becomes very hard and solid.

The Wabash clay is confined to the delta portion of the county and usually borders the front lands. It lies between the Yazoo loam and the Sharkey clay. The largest area lies directly west of Horseshoe Lake. Many smaller areas are found bordering the front lands along the Yazoo River and Tchula and Bee lakes. The surface is level with only here and there slight irregularities due to erosion caused by stream currents cutting across from one drainage system to another in times of unusually high water.

On account of the even topography and the low surface, the natural drainage is poor. Some open ditches have been constructed with satisfactory results. These are preferable to tile drains, since the soil is so compact that many drains would be required and the cost of construction would be greater than the value of the land warrants.

The origin of the Wabash clay is the same as that of the Sharkey clay, both these soils having been laid down in quiet water which had overflowed the banks of the river in times of floods and come to rest in the large interstream areas.

About half of this soil is under cultivation at present and under favorable conditions good crops are produced. It is naturally a very strong soil, and if the proper drainage systems were established its value would be greatly enhanced. Cotton yields from one-half to 1 bale per acre and corn from 20 to 40 bushels per acre.

No fertilizers are used on this soil and no systematic crop rotation is practiced. The acreage devoted to cotton should be reduced and more corn and grass should be grown. Cowpeas should also be introduced into the rotation.

Farms of this type of soil range in value from $10 to $25 an acre.

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The following table gives the results of mechanical analyses of samples of the soil and subsoil of this type:

Mechanical analyses of Wabash clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18403	Soil	0.7	1.9	0.7	1.7	8.9	66.4	19.4
18404	Subsoil	1.1	3.6	1.3	3.0	12.6	57.4	20.2

SHARKEY CLAY.

The surface soil of the Sharkey clay consists of a stiff brown clay extending to a depth of 6 inches. The subsoil, to a depth of 36 inches or more, consists of a stiff, waxy, impervious clay of a drab or mottled color. When dry and exposed to the sun the surface cracks badly and on account of the small masses which are formed it is locally known as "buckshot land." On account of its close compact nature and its poorly drained condition it is very difficult to cultivate.

This type occupies about three-quarters of the delta portion of the county, and next to the Memphis silt loam it is the most extensive soil in the county. The largest body is found on Honey Island, which island is formed by the Yazoo River and Tchula Lake. Another extensive area lies north of Tchula between the lake and the bluffs.

The surface is level, with only a few irregularities caused by erosion and deposition in time of floods when currents cut from one drainage system to another. The type is lower than any of the other soils of the county—but little above the level of the water in the streams. On account of this and its level surface and compact nature the drainage is very poor.

The Sharkey clay is alluvial in origin, having been deposited by the quiet flood waters which came to rest in the large catchment basins of the interstream areas. The soil represents the finest particles held in suspension by the water. These particles were gathered from the upland regions of Mississippi and States farther north, carried into the larger streams by the floods, and then deposited upon these large flood plains as soon as the water came to rest.

Only a comparatively small amount of this soil is under cultivation, but enough has been done with it to demonstrate the fact that it is a very strong soil and will produce well when drained and properly cultivated. The greater part of the type is still in timber and the forests are open and comparatively free from undergrowth. Palmetto is frequently seen along the border of the wooded areas, but this growth does not extend into the forest. The forest growth con-

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sists of white oak, overcup oak, red oak, water oak, and gum, with cypress in the sloughs and swamps. The value of the timber lands is still low, but the future timber supply of the State lies chiefly within the forests of the delta region.

The development of this particular soil is a question which should be seriously considered both by the individual and by the State. There are thousands of acres in this and other counties of the delta which, when once properly drained, will be capable of producing large and profitable crops. Large, open ditches with numerous laterals would greatly assist in carrying off the excess water. This is the method followed in the Louisiana cane fields. Diking and pumping could doubtless be used successfully here, though it would require the expenditure of a large amount of money. The entire soil is not overflowed each year, but to protect against the highest floods it would be necessary to construct a system of levees along all the main and minor streams.

Cotton is the only crop grown to any extent. It yields from one-third bale to 1 bale per acre.

This soil ranges in value from $5 to $20 an acre, depending upon the value of the timber and the location.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of this type:

Mechanical analyses of Sharkey clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18397	Soil	0.0	2.0	1.6	4.0	5.9	44.2	42.3
18398	Subsoil	.3	.8	.5	1.6	8.1	37.9	50.6

MEMPHIS SILT LOAM.

The Memphis silt loam is the most extensive soil type in the area. The surface soil ranges in depth from 6 to 10 inches, with an average of about 8 inches. On many of the steeper slopes the soil has been eroded entirely away, while at the base of these slopes the depth is greater than the average. In color the surface material varies from light brown to a yellowish brown and in all areas the texture is uniformly a silt loam. When wet the soil is somewhat sticky, but when dry it is powdery and has the appearance of flour. The subsoil to a depth of 3 feet or more consists of a brown or chocolate-brown silt loam more compact than the surface soil, containing also a higher percentage of clay. There is no sharp demarcation between soil and subsoil. No difficulty is experienced in cultivating this type, but

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a good mellow seed bed is readily secured with a minimum amount of tillage.

Owing to the composition of this type its field behavior is rather peculiar. Where deep cultivation is followed and there is a comparatively large percentage of organic matter present, the soil is friable and absorbs and retains moisture very well. If shallow cultivation is followed, as is most often the case, the soil packs and puddles during heavy rains and the water runs off instead of being taken up by the soil. The heavy rains carry away large quantities of the surface soil and cut deep ravines and gullies in the slopes. The walls of these washed places as a rule are nearly vertical and vary in height from 3 to 40 feet. The peculiar structure of the material enables them to stand for years while the gullies are being cut deeper by each successive rainfall.

The Memphis silt loam occupies the greater part of the upland section of the county. It is broken only by the strips of lowland along the streams, the outcropping of the underlying Lafayette formation on some of the slopes, and the areas of Richland silt loam which occur chiefly in the southeastern corner of the county.

In topography the land is rolling, broken, and hilly. It consists of a series of irregular ridges and cross ridges the slopes of which are often steep and very much dissected by ravines and gullies. Each rain extends these gullies deeper into the soil and farther up the slopes. The more gentle slopes are also subject to erosion, and when gullies once start in an open field it is very difficult and often impossible to prevent the destruction of the land. These eroded places give a very ragged appearance to the landscape.

The material from which the Memphis silt loam is derived consists of a mantle of loess, varying in depth from 4 to 40 feet. The depth is greatest along the bluffs bordering the delta, the material becoming gradually thinner as the eastern side of the county is approached. The formation consists of unconsolidated yellow silt, and the weathering of the exposed surface material gives rise to the type under consideration. On some of the steep slopes in the eastern part of the county the loess has been entirely removed and the underlying Lafayette formation is exposed. Here the material is a red sandy clay, in many cases covered with a layer of fine sandy loam, which gives rise to the Orangeburg fine sandy loam.

On account of the irregularities of the surface the natural drainage is good. There are a few places about the heads of streams and in small depressions where the drainage is, or has been, deficient and here the subsoil is of a drab or grayish color and small iron concretions are often present.

The original timber growth consisted of a mixture of pine, post oak, red oak, hickory, poplar, beech, and some dogwood. Most of

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the merchantable timber has been cut. The predominating species are now shortleaf pine and scrub oak.

The Memphis silt loam is a safe soil for all general farm crops of this region, and on the more gentle slopes truck crops could be grown successfully. At the present time cotton and corn are the only crops produced to any extent. Yields of cotton range from one-fifth to three-quarters bale per acre, with an average of one-third bale. Corn yields from 8 to 20 bushels with an average of 12 bushels per acre. Oats do very well and are fed in the sheaf, though this crop is not grown extensively. Sweet potatoes, grown only in garden patches, yield at the rate of 100 to 200 bushels per acre. Cowpeas make an excellent stand but are not grown to as great an extent as they should be. Japan clover and Bermuda grass do well and are excellent for hay and pasture. No definite crop rotation is practiced. By following a systematic rotation and intensive cultivation all these yields could be greatly increased.

The methods of culture followed on this soil are similar to those in vogue throughout this section of country. Shallow spring plowing—from 2 to 4 inches—is practiced and ridge cultivation is universal. Cotton and corn are planted on the same field year after year until the land is completely "worn out," when the field is allowed to remain idle for a few years or sometimes abandoned. As a consequence washes start and the land soon becomes badly gullied, so that it is of no further use for cultivated crops.

To improve the physical condition of this soil and in order to secure the best results deep fall or winter plowing should be practiced. The land should be plowed to a depth of 6 to 9 inches and the soil turned up exposed to the pulverizing action of freezing and thawing and the winter rains. In the spring the field should be thoroughly gone over with a disk harrow. Experiments have demonstrated that ridge cultivation is not necessary on the uplands. Instead of planting corn and cotton on the same field year after year a definite crop rotation should be followed. Oats may be sown in the fall and as soon as the crop is harvested cowpeas should be sown. In the fall the cowpeas can be cut for hay and the ground deeply plowed. The next spring, after thoroughly preparing the field, cotton should be planted without bedding the ground. After picking the cotton, the field should again be deeply plowed and left exposed to the elements for the winter. In the spring corn should be planted without bedding and at the last cultivation cowpeas should be sown in the corn. The following year the field may be allowed to grow up to grass and used as a pasture. By following this rotation, or one similar to it, the productiveness of the soil will be greatly increased and the land will not be as apt to wash as under the present system. Green manuring

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should be practiced to assist in building up the soils in need of organic matter. Where stable manure can be obtained it will be found very beneficial in increasing the productivity of the soil.

The steep slopes which are still in forest should be allowed to remain so. Many of the slopes now cleared should never have been cleared, as it is only a matter of a few years until they will become badly gullied and unfit for cultivated crops. An effort should be made to check the erosion wherever this is possible. By throwing brush in the gullies and allowing the fields to reforest, the washing will be checked. On the fields where erosion has not begun it may be prevented by following a system of cultivation which will incorporate a large amount of organic matter in the soil, deepen the surface soil, and make it capable of taking up and retaining a larger part of the rainfall. Contour cultivation will also assist in preventing erosion.

Farms of the Memphis silt loam range in value from $5 to $25 per acre, depending upon their location and the amount of damage done to the land by erosion.

The following table gives the results of mechanical analyses of samples of this soil:

Mechanical analyses of Memphis silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18387	Soil	0.0	0.4	0.7	3.0	2.4	83.6	9.1
18388	Subsoil	.0	.1	.2	.7	5.0	70.9	22.3

RICHLAND SILT LOAM.

The surface soil of the Richland silt loam to an average depth of 12 inches consists of a brown or light-brown silt loam. The subsoil is a chocolate-brown silt loam more compact than the surface and containing a higher percentage of clay. The soil is comparatively easy to cultivate and a mellow seed bed can be readily secured.

The Richland silt loam is confined to the hill section of the county. The largest area is found in the southeastern corner of the county, extending south from Franklin, Ebenezer, and Richland to the county line. Other areas occur along Big Black River, Fannegusha Creek, and some of the other streams.

In topography this soil varies from nearly level to gently rolling. The natural drainage is good, except in depressions and over the areas that are nearly level. In these places tile drains would increase

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the producing power of the soil by carrying away the excess water and by regulating the moisture supply.

In derivation the Richland silt loam is identical with the Memphis silt loam, except that the loess under the Richland silt loam is usually deeper than it is under the Memphis silt loam. There is, however, a marked difference in topography which results in a difference in agricultural value. The soil of the Richland silt loam is deeper and as a rule contains more organic matter than the Memphis silt loam, and is not so badly eroded.

While this type is not nearly so much eroded as the Memphis silt loam, many of the fields are badly washed. Even on land that is nearly level some fields have been abandoned because they have washed so that cultivation can not be continued.

Over the greater part of the Richland silt loam cotton and corn are grown extensively. The methods of cultivation are identical with those described under the head "Memphis silt loam." Because of its smoother topography and slightly better yields, this soil is usually preferred to the Memphis silt loam. Cotton yields from one-quarter to 1 bale per acre, with an average of one-half bale. Corn yields from 10 to 30 bushels, with an average of about 15 bushels per acre.

In the vicinity of Durant the trucking industry has been considerably developed upon this soil and the acreage in these crops is being extended each year. Strawberries, cabbage, and Irish potatoes, in the order named, are receiving the most attention at the present time. Sweet potatoes, peas, beans, and other garden crops are being grown to a limited extent. Plums, peaches, and pears have been tried, and there are several small orchards on this type at the present time, but the pear trees blight badly and late frosts often damage or entirely destroy the crop, and all things considered the outlook for the development of the fruit industry is not especially bright.

Over the part of the type devoted to general farming it is recommended that a systematic crop rotation similar to the one suggested for the Memphis silt loam be followed, and that experiments be tried on a small scale to determine the value of a more extensive use of commercial fertilizers. Deeper plowing and level cultivation should also be practiced. An effort should be made to reclaim the fields which are not too badly eroded and where erosion has not yet begun the greatest care should be exercised to prevent it.

Where trucking is carried on, this soil ranges in value from $30 to $150 an acre. Over the remainder of the type the value ranges from $15 to $25 an acre.

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The following table gives the results of mechanical analyses of samples of the soil and subsoil of this type:

Mechanical analyses of Richland silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18393	Soil	0.0	0.3	0.2	1.2	4.0	86.3	7.8
18394	Subsoil	.0	.1	.3	1.0	5.4	70.2	23.1

ORANGEBURG FINE SANDY LOAM.

The surface soil of the Orangeburg fine sandy loam consists of a brownish-gray fine sandy loam extending to a depth of 8 inches. The subsoil, to a depth of 36 inches, is a red sandy clay, the sand content, however, being very variable.

This soil is derived from the Lafayette formation, which is exposed on some of the steeper slopes in the eastern part of the county, where the covering of loess is at most relatively thin. The natural drainage is good, but the slopes are so steep that the soil is rather difficult to cultivate. The soil washes badly and should never have been cleared. Where cultivated, the yields are small. The value of such land is very low.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of this type:

Mechanical analyses of Orangeburg fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18391	Soil	0.0	0.4	4.6	54.2	6.5	30.1	3.5
18392	Subsoil	.0	.2	7.9	53.0	6.0	7.9	25.5

LINTONIA LOAM.

The surface soil of the Lintonia loam is a brown silt loam extending to a depth of 10 or 14 inches, with an average depth of 12 inches. In local areas the soil contains a high percentage of fine and very fine sand which imparts to it the characteristics of a fine sandy loam. The subsoil consists of a yellowish or brownish silt loam which when dry or nearly so has the feel and appearance of finely ground meal and flour. The subsoil frequently contains lenses of fine sand and in places a small quantity of sand is found throughout the entire soil section.

The Lintonia loam occurs both in the delta and throughout the hill section of the county. In the delta it is found along the foot of the bluffs usually as a narrow band, though in one instance it

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reaches a width of almost 2 miles. In the upland section it occurs along nearly all of the streams as a bottom soil. In origin it is both colluvial and alluvial. The wash from the slopes adjoining the streams has been mixed with the material carried down by the streams in times of heavy rains. In the delta the soil is almost entirely colluvial. The presence of sand is due to the fact that in many cases the material from the Lafayette formation has been washed down and mixed with the loess.

The surface of the type is nearly level, with merely a gentle slope toward the stream along which the soil is found. In the delta the slope is from the foot of the bluffs toward the delta proper. Owing to this gentle slope and the layer of sand which is frequently found in the subsoil, the natural drainage is good, considering the fact that much of the type occurs as a bottom soil along the streams. In the delta where the largest unbroken areas occur, and where the surface is nearly level, tile drains would greatly improve the drainage conditions. This type in the delta is never overflowed, but along the streams in the upland it is sometimes flooded for a short time after heavy rains. In the upland part of the type a ditch should be dug at the foot of each hill, so as to carry off the seepage water and rain wash from the higher ground.

Cotton, corn, sorghum, and sugar cane are grown upon this soil, and it is well adapted to these crops. Oats, Irish potatoes, and grass also do well. Cotton averages about one-half bale and corn from 15 to 40 bushels per acre, with an average of 20 bushels.

Shallow plowing and ridge cultivation are practiced upon this type, and cotton and corn are grown upon the same fields year after year, as is the case on the other soils of the area. Rotation of crops should be practiced, and cowpeas should be grown more extensively to keep up the fertility of the soil.

Farms of this type of soil range in value from $15 to $50 an acre.

The following table gives the average results of mechanical analyses of samples of the soil and subsoil of this type:

Mechanical analyses of Lintonia loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18381, 18383	Soil	0.0	0.0	0.1	0.8	2.0	86.8	10.8
18382, 18384	Subsoil.....	.0	.1	.2	1.3	4.7	81.2	12.0

WAVERLY SILT LOAM.

The Waverly silt loam consists of 8 inches of yellowish-drab silt loam, resting on drab or bluish silt loam somewhat heavier than the soil and extending to a depth of 36 inches or more.

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The type is confined to the delta and near the foot of the bluffs. It is derived from the wash from the loess, which is carried down by heavy rains and spread out at the foot of the hills. It has the same origin as the Lintonia loam, but differs from that type in that it is low-lying, poorly drained, and as yet little developed. Only a few fields have been cleared, and it is not likely that much of the type will be put under cultivation until better drainage is established. The greater part of it is subject to overflow and parts of it are in the condition of swamp.

The Waverly silt loam has a very low agricultural value at the present time, but when cleared and well drained it will be capable of producing large yields of all the crops commonly grown in the area.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of this type:

Mechanical analyses of Waverly silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18405	Soil	0.0	0.4	2.1	4.2	10.7	77.9	4.8
18406	Subsoil	.0	.1	.2	.7	15.8	79.4	3.5

NORFOLK GRAVELLY LOAM.

The surface soil of the Norfolk gravelly loam consists of a light-brown, medium sandy loam extending to a depth of 8 to 10 inches. There is present on the surface and mixed with the soil from 15 to 25 per cent of gravel, the fragments seldom exceeding 1 inch in diameter. The subsoil to a depth of 30 inches consists of a yellowish sand or sandy loam containing from 10 to 15 per cent of gravel. A gravel bed is sometimes encountered at 3 feet. Both soil and subsoil are subject to considerable variation. The soil may be a heavy sandy loam and the subsoil may grade into a heavy loam, silty loam, or clay loam at 2 or 3 feet.

This type occurs immediately at the foot of the bluffs bordering the delta and is derived from the Lafayette formation, which, lying immediately under the loess, is here exposed. The wash from the bluffs carries down the material from both of these formations, and the coarse material is left near the bluffs, while the finer and lighter particles are carried farther on. The Norfolk gravelly loam occupies only a narrow margin between the hills and the delta. It varies in width from a few rods to one-half mile, though it is not continuous.

The surface always has a gentle slope toward the delta and the natural drainage is good. It sometimes suffers from drought. The greater proportion of this soil has been under cultivation, but much

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of it has been abandoned and allowed to grow up to sedge and brush.

The yields are small except during seasons of excessive rainfall. The soil is so loose and open that moisture is not long retained. The price of land of this type of soil ranges from $5 to $15 an acre.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of this type:

Mechanical analyses of Norfolk gravelly loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18389	Soil	1.5	17.3	28.7	15.0	6.3	26.9	4.7
18390	Subsoil	.9	15.3	35.1	18.8	7.6	19.7	2.7

MEADOW.

The surface few inches of the material composing the Meadow consists of a brown or drab silt loam. This is underlain by a drab, gray, or bluish silt or silty clay. In local areas and especially near the streams there is considerable sand present in both soil and subsoil.

The Meadow includes the lowlands along the streams of the upland section of the county, which are now unsuitable for tillage, and which never have been cleared of the original timber. This growth consists of water oak, black and sweet gum, sycamore, beech, and some cypress. The most extensive development is along the Big Black River. The surface is flat and broken only by sloughs, old oxbows, and bayous, former channels of the river. It is liable to overflow at any time of the year, and after heavy rains is always covered with water, which may stand on the surface for two or three weeks.

The type is still in process of formation, each successive flood bringing with it material that is left as a thin deposit over the bottoms. The soil is very rich, and if cleared, ditched, and diked would be capable of producing large yields. At present it is of value only for its timber and the pasture which it affords.

SUMMARY.

Holmes County, Miss., lies a little to the northwest of the center of the State and comprises an area of 524,992 acres or about 820 square miles. The drainage of the entire region is through the Yazoo and Big Black rivers into the Mississippi. The eastern two-thirds of the area lies in the upland section of the State, while the western one-third is within the Delta. The surface of the upland region varies from nearly level to rough and broken, with many badly eroded places. The Delta is almost level, although sloping gently away from the streams and bayous.

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The first settlement in the area was made in 1826 and the county was organized in 1833. At present it has a population of 36,828. Lexington, the county seat, has a population of 2,000.

The area is traversed from north to south by the main line and a branch of the Illinois Central Railroad, and these two lines are connected by a small road running from east to west. Durant, a city of 2,300, on the main line, is 680 miles from Chicago and 242 miles from New Orleans.

The mean annual temperature of this region is 65° F., with a maximum of 107° and a minimum of —2°. The mean precipitation is 48.1 inches. The winters are mild, though the weather is very changeable, and the summers are long and warm.

The agriculture of the area is now in process of evolution and improvement. Cotton is still the money crop. The oats, corn, and hay produced are not sufficient to supply the home demand. The small fruit and trucking industries have been developed in the vicinity of Durant. The outlook for the fruit industry is not especially bright, but trucking can be profitably extended.

The average size of farms is 69.9 acres; individual holdings vary from 20 to 5,000 acres.

The average price of delta lands well located and about half cleared is $35 an acre, with a range from $8 to $60 an acre. In the hills the range in value is from $5 an acre in the eroded sections to $150 in the trucking region.

A systematic crop rotation should be followed, deeper plowing practiced, and, especially in the hills, ridge cultivation abandoned. More attention should be given to dairying and the raising of beef cattle and hogs. Winter forage crops such as rye, barley, oats, and vetch should be grown more extensively. Cowpeas, alfalfa, and other legumes may be used to increase the fertility of the soil as well as to furnish an abundance of nutritious feed. The washing of the soil may be greatly checked by deep cultivation and the incorporation of more organic matter in the surface soil.

The soils of the upland part of the county are derived from the mantle of loess which covers a large area in the State. Memphis silt loam is the most extensive type in the county. Its surface is rough and broken and in many places so badly eroded that it is of no value for cultivated crops. Its peculiar structure permits it to be readily washed away during heavy rains.

Richland silt loam has the same origin as the Memphis silt loam, and is also confined to the hill part of the county. Its surface is nearly level or gently rolling, and it is not as badly eroded as the former type. The soil is deeper than the Memphis loam, and it has a higher agricultural value. The trucking industry has been developed on this type.

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The Lintonia loam is found along the stream bottoms in the uplands and at the foot of the bluffs, in the delta. It is a wash from the loess slopes, and is a distinct type. Along the streams it is sometimes flooded, but in the delta it is not subject to inundation. It is fairly well drained and is capable of being highly developed. Most of it is now under cultivation.

Waverly silt loam is also a wash from the loess slopes. It is confined to the delta and lies adjacent to the Lintonia loam. It is very low, subject to overflow, and much of it is now in the condition of swamp.

The type Norfolk gravelly loam occurs immediately at the foot of the bluffs, and is the result of wash from the Lafayette formation which is exposed below the loess. It is of very small extent and of little agricultural importance.

The term Meadow has been applied to the low-lying areas along the streams of the upland which are still uncleared, subject to overflow and wet most of the year.

The soils of the delta proper are all of alluvial origin, having been laid down by the Mississippi River and its tributaries in times of high water. The Yazoo fine sandy loam occupies the long, narrow ridges which border the water courses and form the front land. The type is of small extent, but practically all of it is under cultivation. It is very seldom flooded.

The Yazoo loam lies adjacent to the Yazoo fine sandy loam in long, narrow bands, and is a gradation type from the sandy soil to the heavy clays of the interior. It has a gentle slope away from the streams or water courses along which it is found and its natural drainage is fair, though parts of it are subject to overflow. It is the best soil in the delta.

The Wabash clay lies adjacent to the Yazoo loam and borders the large open swamps of the interstream areas. It is a strong soil, but is low and subject to overflow. If properly drained and well cultivated it will produce large yields.

The Sharkey clay occupies large interstream areas commonly called the "open swamp." It is the heaviest soil in the area and practically undeveloped. It is nearly all in timber, only a very small proportion having been cleared. It is naturally a strong soil, and if diked, ditched, and properly cultivated would be capable of producing excellent crops.

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SOIL SURVEY OF MONROE COUNTY, MISSISSIPPI.

By R. A. WINSTON, ORA LEE, Jr., A. W. MANGUM, W. J. LATIMER, A. E. KOCHER, and HOWARD C. SMITH.

DESCRIPTION OF THE AREA.

Monroe County is situated in northeastern Mississippi, in the first tier of counties along the Alabama line, and about 65 miles south of the Tennessee border. It was established in 1821, named in honor of James Monroe, and, as now constituted, is bounded on the north by Lee and Itawamba counties, on the east by Alabama, on the south by Clay and Lowndes counties, and on the west by Clay and Chickasaw counties.

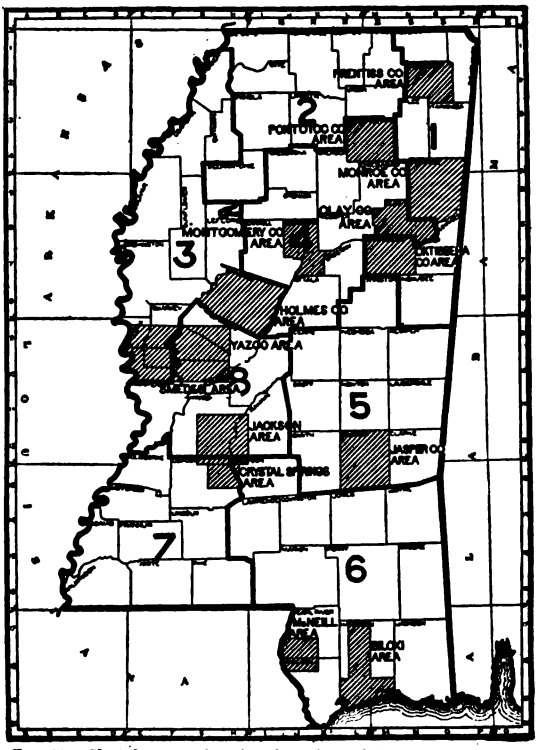

FIG. 20.—Sketch map showing location of the Monroe County area, Mississippi.

The county of Monroe has, since its inception, sustained numerous modifications both as to shape and extent, but as now outlined it is roughly rectangular in shape and comprises an area of 761 square miles or 487,040 acres.

The topography of the county is rolling to undulating or comparatively level. The western two-thirds, with an approximate elevation of 300 feet, is characterized by comparatively smooth surface features, while the eastern one-third, constituting largely the hilly divide between the Tombigbee and Buttahatchie rivers, with an average elevation of about 375 feet, shows a rather strong relief. The general slope of the area is to the south, with regional drainage in a southerly direction and toward the principal drainage lines. The gently rolling to undulating limestone lands in the west give

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way to the comparatively level to gently rolling "flatwoods" and "post oak" lands to the east, and these in turn pass into the broad and level valley lands of the Tombigbee River, which flows across the central part of the county from north to south and with its tributaries constitutes the important drainage system of the area.

To the east of the Tombigbee drainage system is a hilly divide crossing the entire county from north to south, paralleling the valley lands. This narrow divide separates the waters of the Tombigbee River from those of the Buttahatchie River, the other important drainage line of the area. The valley of the Buttahatchie River, which is from 2 to 4 miles wide, has a rather level topography. The narrow strip of country between the river and the Alabama line is rolling to hilly, with drainage to the west into the river.

The early history of the section, prior to 1820, appertains almost exclusively to the Indians. The Federal Government instituted what is known as the Huntsville survey about 1820, opening up to settlement the lands eastward from the Huntsville meridian to the Tombigbee River and as far north as the Old Indian trail known as "Gaines Trace." The opening of these lands resulted in an influx of immigrants from sections of Georgia, Alabama, and especially from Tennessee, and their advent marks the time of the county's establishment. After the completion of the Chickasaw survey, about 1836, and the organization of the Chickasaw cession of 1832 into counties, opening up to settlement the fertile lands east of the Tombigbee River, there came many other immigrants from Georgia, Alabama, and Tennessee, representing largely descendants of the old Virginia and Carolina families who had settled chiefly along the Tennessee River in North Alabama, though to some extent in other sections of the mentioned States. These immigrants were in the main people of wealth, and among them was a strong sprinkling of the best Scotch and Irish elements. The Britons were also strongly represented. The advent of the negro dates from the time of the original settlement. Many additions were made from time to time to the county's population from the several States of the Union, but the present citizenship is practically all native and quite homogeneous.

The lands east of the Tombigbee River were the first settled, but with a steadily increasing population and enhancing land values, settlements were soon made on the lands west of the river. At present the settlement of the county is fairly general, though more dense in the gently rolling limestone lands in the western and the comparatively level to rolling lands in the northern, central, and southern sections. The hilly areas in the east and northeast sections of the "flatwoods" and a large portion of the low-lying alluvial soils along the larger stream courses are thinly settled and are the lowest in agricultural value under present conditions. Naturally the productiveness of the soil, its ease of cultivation, and the conveniences

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of market facilities are the three factors determining largely the extent of settlement, and hence the country along the various railroad lines and near the commercial centers represent, in general, the portions of the county most thickly settled and most highly developed.

No section of the county has as yet reached a condition of settlement even approaching its capacity, and lands that are naturally unsuited to the staple crops have not been brought under cultivation, and even considerable areas of the more easily cultivated soils are handled with little regard to securing maximum yields. The conveniences of telephonic connections, rural mail delivery routes, etc., do much toward making the rural sections attractive, and with the establishment of good roads the unused lands will be brought under cultivation.

The population of the county in 1900, according to the Twelfth Census, was 31,216, of which 12,555 were white and 18,661 colored. Aberdeen, the county seat, situated near the center of the county on the Tombigbee River, is a thriving commercial center of 5,000 inhabitants and the largest town of the county. There are several industrial enterprises of importance located at this point, which utilize some of the natural resources of the section. Three branch lines of railroads enter the town, and the Aberdeen and Tombigbee Valley Railroad from Okolona to Pensacola, Fla., now in process of construction, is expected to furnish the town with one through line. Amory, in the north-central part of the county, on the Frisco Railroad, is also a thriving town of 1,500 inhabitants and the second in importance in the county. Gibson, Prairie, and Muldon, on the Mobile and Ohio Railroad, Strongs, on the Illinois Central Railroad, and Bigbee, Quincy, and Gattman, on the Frisco, are local railroad settlements, while Smithville, Athens, and Hamilton, in the northern, central, and southern parts of the county, respectively, are small rural towns and among the oldest settlements in this section of the State. Greenwood Springs, in the eastern part, is a small settlement on the Frisco Railroad and a summer resort of much local importance.

Monroe County is traversed by three systems of railroads now in operation and a fourth one in process of construction. The Frisco crosses the northeastern section in a northwest and southeast direction, with a branch line extending from Amory to Aberdeen. The Mobile and Ohio traverses the western prairie belt from north to south, with a branch line from Muldon to Aberdeen. The Aberdeen and Tombigbee Valley Railroad, now building, will traverse the central part of the county in a northwest and southeast direction. This network of railroads, with their numerous local shipping points, directly connecting the large centers of the South, affords all sections of the county convenient and ample market facilities.

The public roads are as yet largely unimproved, though a recent inauguration of the contract plan for improving them is giving some

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good results. There is an abundance of gravel in various sections of the county, and while little of this material has been utilized so far for road building, it will eventually be used for this purpose. A system of good roads would greatly promote the general welfare of the entire area.

The drinking water of the county is obtained from surface wells from 10 to 75 feet deep, and from artesian wells, from 250 to 2,000 feet in depth. The surface wells are invariably good, except when subject to the leachings of the limestome rock high in calcium carbonate, when the lime content tends to make the water unpalatable. The artesian wells supply a healthful water that invariably contains some iron salts. In many sections of the county, especially over the level sandy valleys of the Tombigbee and Buttahatchie rivers, the bountiful supply of artesian water may become of much value for irrigating truck or other special crops.

CLIMATE.

The climate of Monroe County is typical of the warm temperate zone of the Southern States. The winters are relatively short and mild and the summers are long and hot, a condition that affords a long growing season for crops, as well as a wide range for diversification. Cultivation can be carried on practically the year around. The county is situated too far from the Gulf to be affected by the Gulf breezes, and its elevation above sea level is insufficient to give it a rarefied atmosphere. The temperature ranges from 25° F. in winter to 100° F. in summer, with an average of about 42° for the winter and 80° for the summer. There are frequent variations during the winter months, but none of an extreme nature. Freezes may occur from time to time, but they are of short duration. Snows rarely occur. The humidity intensifies the sensible temperature during the winter months as well as the heat of summer, which is generally oppressive from June to September.

The following table, compiled from the records of the Weather Bureau station at Aberdeen, shows the dates of the last killing frosts in spring and the first in fall for a series of years, with average dates for the entire period:

Dates of first and last killing frosts at Aberdeen.

Year.	Last in spring.	First in fall.	Year.	Last in spring.	First in fall.
1898	Apr. —	Oct. 27	1903	Mar. 26	Oct. 25
1899	Mar. 26	Nov. 3	1904	Apr. 5	Oct. 23
1900	Apr. 1	.....	1906	Mar. 21	Oct. 11
1901	.....	Nov. 6	1907	Apr. 14	Oct. 29
1902	.....	Nov. 28	Average	Mar. 31	Oct. 31

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The annual rainfall is about 47 inches, with the highest average precipitation during the winter and spring months and the lowest during the months of September, October, and November. The rainfall is fairly well distributed throughout the year and crops seldom suffer from drought, and tillage methods looking to the conservation of the soil moisture would prevent any possible damage to crops from the occasional dry seasons. Summer rains usually occur in the form of showers or thunderstorms, while the winter rains are continuous downpours, resulting in much erosion over the rolling areas and extensive flooding of the depressions and valleys.

The following table, compiled from the records of the Aberdeen station, gives the normal monthly and annual temperature and precipitation:

Normal monthly and annual temperature and precipitation at Aberdeen.

Month.	Temperature.	Precipitation.	Month.	Temperature.	Precipitation.
	° *F.*	*Inches.*		° *F.*	*Inches.*
January	41.4	3.99	August	78.6	3.77
February	40.6	5.13	September	72.6	2.62
March	54.4	5.41	October	61.0	1.98
April	62.2	3.63	November	50.4	3.14
May	70.3	2.86	December	42.2	4.84
June	78.1	5.24			
July	80.3	4.41	Year	61.0	47.02

AGRICULTURE.

The territory now embraced within the limits of Monroe County was originally a part of the Chickasaw Indian domain. The treaty of 1816 on the part of the Chickasaw Nation gave the National Government the lands included in the "Original county of Monroe," consisting of some half million acres along the Creek frontier. All claims to this land were adjusted within a few years, and Mississippi recognized it as a possession in 1821, establishing the county. The valley of the Tombigbee River is probably the earliest line of settlement in northern Mississippi and the section first given to active agricultural pursuits. The earliest settlers coming to the frontier made their homes on the lighter sandy soils east of the river, where cultivation was easy and a water supply plentiful. The oldest settlement in the county, and probably the oldest abandoned town in northern Mississippi, is Cotton Gin Port, on the Tombigbee River, some 4 miles west of Amory. This was an important frontier post when the treaty of the Chickasaw Custom House made Gaines Trace and the Tombigbee River boundary lines between American and Chickasaw territory.

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The agriculture of these early days consisted of a crude culture of cotton, corn, fruits, and vegetables over the more easily tilled and productive soils. The pioneer settlers, as well as the Indians, obtained a livelihood chiefly by fishing and trapping, supplementing their food supply by growing limited areas of corn and vegetables. To encourage the growing of cotton and to pacify the prejudices of the Indians, the Federal Government constructed a primitive cotton gin at this frontier post over one hundred years ago. Old Hamilton, in the southern part of the county, in the forks of the Buttahatchie and the Tombigbee rivers, was also an early settlement and the county seat until 1830, when the distinction was transferred to Athens, in the central part of the present county. Aberdeen, laid out in the thirties and incorporated in 1837, was made the county seat in 1849 and has been the chief agricultural center ever since.

Cotton soon became the leading crop. Horsepower gins were used, and the raw product was shipped from Cotton Gin Port and later from Aberdeen by way of the Tombigbee River to Mobile, where it was exchanged for money and the year's supplies. The later introduction of steam gins gave an impetus to cotton production and the acreage was steadily increased. The production of grain and other common farm crops kept pace with the agricultural development. In the early sixties the Mobile and Ohio Railroad traversed the western part of the county from north to south, affording more convenient facilities for marketing the cotton crop and for the importation of supplies. It was some years later that Aberdeen, the chief distributing point, was connected by a branch line from Muldon.

The agricultural pursuits of Monroe County have not materially changed since its early history. Conditions have improved with settlement, development, and general advancement, but the area has always been distinctly a cotton-growing section, with corn, oats, wheat, sorghum, melons, potatoes, peanuts, vegetables, numerous fruits, berries, cowpeas, alfalfa, Johnson grass, melilotus, etc., as supplementary crops to meet in part the demands of the community. No general system of growing crops in beneficial rotation has ever been practiced, and until very recently no attention has been given to the adaptation of soils to crops.

Commercial fertilizers are used extensively on the lighter sandy soils, while the "prairies," or limestone lands, are devoted year after year to the production of cotton or corn without fertilizers of any kind. These limestone soils being probably the strongest of the area, can better withstand the continual drain of the one-crop system, but the lighter sandy soils of the east are soon reduced to a low producing capacity. The average yield of cotton on the limestone lands is about one-half bale to the acre, the moderate yield being due to the clean-culture, one-crop system, and inadequate tillage methods. Yields

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may be higher or lower, according to climatic conditions or seasons, but it is quite feasible to employ methods of cropping and of tillage that could control almost any adverse conditions and bring about a consistent good yield. The adaptation of this limestone soil to alfalfa is being quite generally recognized, and the acreage of this crop is increasing from year to year with paying returns. It will probably prove one of the very profitable staple crops of the prairie belt.

The lighter sandy soils, which occur largely east of the Tombigbee River, are better adapted to a variety of crops than the black prairie clays, and while their productiveness may be reduced through inconsiderate methods of cropping and cultivation, they are capable of giving profitable crops indefinitely if properly cultivated. They are easily handled, well drained, respond readily to fertilizers, and are susceptible of permanent improvement, and in this case particularly the importance of crop rotation, adequate tillage methods, and the addition of organic matter can not be overestimated. In the absence of stable manures, a leguminous crop every two or three years, preferably cowpeas, to be plowed under, is recommended to supply the necessary humus to the soil.

Cultivation is practically along the same lines as it was years ago, except by some of the more progressive farmers, who employ efficient labor-saving machinery and practice improved methods leading to intensive cultivation. Crops are, however, generally planted and matured with as little expense as possible. The preparation of the land commences immediately after the late winter rains of January and February, when the land is broken from 3 to 5 inches deep and allowed to stand until planting season before it is bedded and seeded. The method generally followed is to allow the cotton lands to remain untouched throughout the winter season, and to prepare them for cotton in the spring by simply running a plow down the old seed bed and bedding the land over the old bed furrow between the former rows. During the planting season, or when the land is bedded, commercial fertilizers are drilled in at the rate of about 200 to 300 pounds to the acre. Some of the more progressive farmers who own and cultivate their own farms have adopted methods that are far more effective in producing increasing yields. The crops are rotated, and the lands are plowed deeply in the fall and seeded with some winter cover crop, which prevents any extensive washing and also affords a supply of organic matter with its resultant benefits.

The present careless and inefficient treatment of land is due largely to the prevailing system of tenantry. The tenant, having only an immediate and temporary interest in the land he tills, plants and matures his crops of cotton and corn with the least possible expense, curtailing tillage and fertilizer applications to a minimum, which practice, while disastrous to the land, is nevertheless profitable to the

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landowner, for his share of the crop returns is a high interest on the value of the lands. In certain sections of the county the good yields on limited areas well cultivated by the owners are in noticeable contrast to the results secured by the average tenant farmer.

The one great inexhaustible natural resource of the county is the soil, and the area will always be, primarily, an agricultural district. No section of it has yet reached its possible producing capacity. The abundance of land, conditions of tenure, and the easy methods of cultivation are factors retarding a more progressive and more highly developed agriculture, but a spirit of progress is clearly shown by an increasing interest in agricultural pursuits and a more general prosperity throughout the county.

To effect a more comprehensive utilization of the great soil resources of the county and to bring about a more intensive and profitable agriculture the following suggestions are offered: First, a wider diversification of crops, including possibly the introduction of new crops and the selection of crops according to soil adaptation; second, the more economic production of the staple crops of cotton and corn, which can be largely brought about by deeper plowing, to prevent erosion and to produce a superior seed bed; third, a systematic rotation of crops, including the frequent use of cover crops to be plowed under, preferably a legume, to supply necessary humus to the soil, and last, the practice of careful seed selection.

The farm labor is largely colored and the supply is usually equal to the demand. It is chiefly unskilled, but fairly efficient under supervision. The method of employment is usually by contract for the year, with a monthly wage of from $10 to $15 with subsistence, though much day labor is employed, especially during the rush of the cotton chopping and cotton picking seasons. The daily wage ranges from 75 cents to $1.50, the rate being determined by the demand. Occasionally day labor is paid by piecework, which averages about $1 a day. The cotton chopper receives so much per acre and the cotton picker so much per hundred pounds, the price being about $1 per acre for choppers and about 75 cents a hundred pounds for picking.

Owing to the absence of near-by industrial centers the native labor is fairly well distributed throughout the area, and while the labor is not entirely adequate and satisfactory, the question presents no such serious difficulty here as exists in many other sections of the South.

For the most part the farming is carried on by tenants on a share basis or for a cash rent per acre. When the owner furnishes all work stock, land, seed, and house for tenant, he receives one-half of all crops; when he furnishes only the land and a house for the tenant he receives one-fourth the products. The cash renter pays $2 to $5 an acre, according to the productiveness of the land; the black

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prairies, being the most productive soils, naturally command the highest rent.

According to the census of 1900 there were 372,738 acres in farms, of which 187,404 were improved. The average size farm was 76.8 acres, and 27.9 per cent of the farms were operated by owners. The value of farm lands and improvements, farm buildings, implements, and machinery, and live stock amounted in 1899 to $4,985,595, the expenditures for labor and fertilizers $82,910, and the value of products not fed to live stock $2,009,066.

SOILS.

Monroe County lies wholly within the broad physiographic division known as the Coastal Plain Region. Various geological formations influence the character of the soil material, and while the soils follow more or less distinctly the broad lines of the original formations, many complications are encountered. Three geological formations constitute the substrata of the county—the Selma chalk in the western, the Eutaw (Tombigbee) in the central, and the Tuscaloosa in the eastern part—all extending in a general north and south direction and belonging to Cretaceous time. The Selma chalk alone of these three formations gives rise to a soil material uninfluenced by more recent deposits, the Eutaw and Tuscaloosa being covered by the sedimentary Lafayette and Columbia formation and to a less extent by alluvial deposits of Recent age.

The Selma chalk formation, or rotten limestone, is a stratum of impure fine-grained Cretaceous limestone, underlying the western part of the county. Its thickness varies from less than a hundred to several hundred feet, the depth increasing toward the south, and the percentage of calcium carbonate also becomes higher as one proceeds south. The formation was laid down in a rapidly deepening sea at the close of Cretaceous time and has in its unchanged condition a characteristic bluish tint. On weathering it becomes a whitish color, while the resulting soil product invariably has a dark-gray to black color. This formation gives rise to the broad "prairie" or "black lands" in the western part of the county, the soil being technically known as the Houston clay.

In the more rolling areas or bluffs that skirt the stream bottoms small areas of the exposed limestone frequently occur, resulting from severe erosion; such areas were mapped as Houston chalk. The reworked material from the limestone found as marginal strips of varying breadth along the streams that flow through the limestone areas, having been transported through the action of surface waters or taken in suspension and deposited at lower levels during periods of excessive rainfall and overflow, is designated as Trinity clay. To the west of the Houston clay and extending, roughly, to the more

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recent deposits of the rolling sandy country and the Tombigbee Valley soils, are extensive, comparatively level to rolling areas, the soil material of which is closely related to the Selma chalk derivatives. These areas support a growth of hardwood and include much of the land that is locally termed "post-oak land." The formation giving rise to this material appears to be more or less calcareous laminated clay. It is a later deposit than the Selma chalk, and was evidently laid down while the lime rock was yet submerged. Capping some of the higher elevations over this formation is a thin mantle of the Lafayette, which no doubt influences the color of at least some small areas. Over the zone of this argillaceous deposit the Oktibbeha clay, Oktibbeha clay loam, and Oktibbeha silt loam are developed extensively, while in depressions and poorly drained areas the Lufkin clay predominates, with some small areas of the Lufkin silt loam.

The soil material east of the general line of the Tombigbee River belongs to Quaternary time and includes the Lafayette, Columbia, and Recent deposits. The Lafayette formation, consisting of strata of sand and sandy clay, is developed extensively over the rolling and hilly divide between the Buttahatchie and Tombigbee rivers, extending entirely across the county from north to south. It also occurs in small areas about 3 miles south of Aberdeen and in the forks of Old Town Creek and the Tombigbee River, in the northern part of the county.

Throughout the extent of this formation occur the Orangeburg soils, the Orangeburg fine sandy loam predominating. Wherever erosion has been active in transporting the sandy surface material, the sandy clay has been exposed, giving rise to the Orangeburg clay type, which is found chiefly on the slopes of the hills or ridges.

Closely associated with the Orangeburg soils is the Guin type of soil, found extensively in the northeastern and eastern sections of the county upon the rolling to hilly uplands skirting the Buttahatchie Valley, the Sipsie River Valley, and Splunge Creek. Over some of the hills occupied by the Guin fine sandy loam are found ferruginous sandstone masses, the only consolidated rock fragments found in the area. This soil is developed extensively in Lamar County, Ala., under the same conditions as in this county. The color is a brownish to reddish yellow, and the soil differs from those of the Orangeburg series chiefly as to color. The sedimentary deposit is no doubt of the same age as the Lafayette, its color being influenced by manner of deposition or mineralogical composition. Being, as a rule, of very hilly topography, the Guin fine sandy loam has little agricultural value and is prized chiefly for its timber growth of hardwood and pine.

The Columbia formation, consisting of a deposit of brown and yellow loams, is found extensively over the broad and gently rolling

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to undulating strip of country between the Tombigbee River and the hilly divide separating the two large drainage lines. It also mantles certain areas of the Lafayette formation, as evidenced by outcrops of that red material on the slopes or escarpments passing to lower levels. It is possible that the Guin type of soil owes its origin in part to this formation, for these brown and yellow loams are found over most of the hill country of Mississippi.

The yellow loams in this area have given rise to the Norfolk fine sandy loam and Cahaba silt loam, while the brown material has influenced the development of the Amory fine sandy loam.

In the depressions and poorly drained areas which admit of little or no aeration and oxidation, the underlying clays are generally of a tenacious, impervious nature and a grayish-white color; such areas were included in the Lufkin series.

The recent deposits give rise to all the types established along the stream courses. These have been formed through water action since the recession of the ancient sea. The Tombigbee River Valley, varying in breadth from 2 to 6 miles, shows a compilation of soil material which results in several types of soil. Comparatively little of these bottoms is under cultivation. Three soils were mapped as follows: Cahaba fine sandy loam, Cahaba loam, and Ocklocknee clay loam, with boundaries more or less arbitrarily drawn. The Cahaba fine sandy loam occurs over the highest and oldest of the alluvial terraces and is little subject to overflow. The line of separation from adjoining soils derived from distinct geological formations is often insensible and as drawn wholly arbitrary. The Cahaba loam represents a rather silty material along second bottoms, and is inundated during excessive rainfall. The Ocklocknee clay loam includes all the immediate overflow lands and depressions which may be found scattered promiscuously over the valley area. By far the larger part of the Tombigbee bottoms is thickly covered with hardwood and gum and a luxuriant growth of underbrush. A detail traverse of this section would have required more time than seemed to be justifiable. Extensive drainage will be necessary before these fertile soils can be developed for agricultural purposes. The Ocklocknee silt loam is a valley or bottom soil of the Buttahatchie River, differing slightly from those of the Tombigbee River, on account of the limestone wash of the latter. Along the smaller streams the alluvial material gives rise to the Ocklocknee loam.

Twenty-two types of soil were established in the county, occurring chiefly as derivative material from the underlying geological formations and as reworked material transported by surface waters or taken into suspension and deposited by the river waters during seasons of overflow. Local conditions of erosion, oxidation, etc.,

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have combined to modify certain small areas over extensive types, and, in some instances, have resulted in creating such characteristic differences that distinct soil types have been formed.

The following table gives the name and the actual and relative extent of each type:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Orangeburg fine sandy loam	92,992	19.1	Amory fine sandy loam	15,744	3.2
Houston clay	58,176	12.0	Cahaba loam	15,232	3.1
Cahaba silt loam	49,664	10.2	Lufkin silt loam	12,352	2.5
Cahaba fine sandy loam	33,024	6.8	Oktibbeha clay	11,456	2.4
Guin fine sandy loam	29,568	6.1	Lufkin clay	3,392	.7
Trinity clay	27,904	5.7	Myatt fine sandy loam	2,432	.5
Oktibbeha clay loam	24,000	4.9	Susquehanna fine sandy loam	1,664	.3
Ocklocknee clay loam	23,616	4.9	Oktibbeha fine sandy loam	1,664	.3
Ocklocknee loam	22,912	4.7	Orangeburg clay	1,600	.3
Oktibbeha silt loam	22,400	4.6	Houston chalk	512	.1
Ocklocknee silt loam	20,544	4.2			
Norfolk fine sandy loam	16,192	3.4	Total	487,040	.....

It is thus seen that Monroe County offers a diversity of soil types sufficient to warrant a very diversified agriculture. The fertile first and second bottoms along the Tombigbee and Buttahatchie rivers, together with the alluvial soils of their larger tributaries, present a vast acreage of clay loams, loams, and sandy loams that are susceptible to improvement and a profitable use in the production of many different crops. The upland soils vary in structure from the stiff, heavy black clays of the undulating prairie land to the light sandy soils of the hilly sections in the eastern part of the county. None of these soils are as yet given to intensive cultivation and little regard is paid to their fitness for special crops. Yields are generally rather low, and cultivation is confined largely to the stronger or more easily tilled areas. The limestone soils are probably the strongest of the area and, despite the continual drain of the clean-culture, one-crop system, they maintain a rather high state of productiveness. The lighter sandy soils under similar treatment are soon reduced in productivity, and commercial fertilizers are demanded for profitable returns. With the introduction of improved methods and a proper system of crop rotation these soils can be vastly strengthened and improved. There is very little land in the county that can be considered of doubtful value for agriculture.

HOUSTON CLAY.

The soil of the Houston clay, to a depth of from 10 to 15 inches, is a brownish-gray to black clay loam to clay. It grades or often passes more abruptly into a lighter-colored subsoil of practically the same

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texture, being, however, more plastic and tenacious, because of the higher moisture content and the lower content of organic matter. The type varies somewhat where influenced by difference in topography or the proximity of other geological formations. Areas were encountered which showed a black to drab-colored material 3 feet deep, such areas being confined chiefly to the rather level or depressed sections of the prairie belt. The brownish-gray phase is found only on the slopes of the gentle swells or knolls that mark the more elevated areas. This phase may show a decided brownish color 3 feet deep, or, where the limestone is sufficiently near the surface, the whitish partially rotted material may be encountered at from 24 to 36 inches. Small rock fragments, remaining from the weathering of the limestone, are quite numerous. Much of the typical Houston clay of this area will show a decided brownish clay subsoil underneath the dark-gray to black surface soil, with the brownish material resting directly on the unaltered Selma chalk formation. The brownish color of the material in this position is no doubt due to the oxidation of certain iron compounds in the original limestone. That the coloring does not extend to the surface is due to the complete process of weathering, thorough leaching, and the incorporation of more or less organic matter. Where the limestone is consistently at or near the surface, as is true only of the more rolling sections of the prairie lands or along the slopes of stream valleys, the surface soil will vary from brown to a grayish white in color, and the subsoil will show a correspondingly grayish-white color with the rotten lime rock at from 18 to 36 inches below the surface. Such areas generally show some fossil shells that have remained from the weathering of the limestone material.

The Houston clay being of very fine texture and close structure becomes quite sticky and tenacious when wet and bakes hard on drying. Cultivation is more or less difficult, but when handled at the right moisture content the soil becomes loamy and friable.

The type occurs in the western part of the county from north to south and is known as the "prairie," or "black lands." The limestone formation from which it is derived is continuous with the formation that is found extensively in Lee, Chickasaw, Clay, Lowndes, Oktibbeha, and Noxubee counties, where it gives rise probably to similar soil conditions.

The surface of the Houston clay is undulating to very gently rolling, with some comparatively level areas in the prairie belt proper and some rather hilly areas along the border of the limestone formation. Drainage as a rule is good, though much of the lower lying areas or depressions would be benefited by artificial drainage, preferably by the use of tile. From the crests of the gentle elevations there is an easy decline to the broad and shallow valleys which furnish outlet for excess rainfall. Such a condition precludes any severe or even harm-

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ful erosion, if any regard be given this feature of soil management. The larger drainage lines show broad and comparatively level valleys with well-worn stream channels from 6 to 25 feet deep, which can accommodate all rainfall, except during the heavy rainy seasons when the entire valleys may be inundated. On the more rolling to hilly areas erosion is often more or less severe, and numerous gullies or washes are often found extending down the slopes, or the rotten limestone may be exposed, giving rise to the type of soil mapped as Houston chalk.

The Houston clay is derived from the weathering of the Selma chalk formation of Cretaceous age. This formation is a rather impure and loosely structured lime rock. There appears to be a covering of a later calcareous deposit, often approaching an argillaceous shale, over a portion of the Selma chalk formation, probably laid down while the lime rock was under water, and this later material enters into the formation of portions of the Houston clay, though, by itself, it gives rise to a soil material so different from Houston soils that a new soil series was established to cover it. No doubt the larger part of the Houston clay represents the residue from the weathering of the limestone formation, without the admixture of any other material.

This Houston clay supports no timber growth, and practically all of the type is cultivated except the rather hilly areas, which are left in native grasses and utilized as pasture. Cotton and corn are the chief crops, though the recent introduction of alfalfa and its successful culture may make this one of the staple crops of the limestone lands. While the soil is not well suited to trucking, various vegetables in small patches are grown for home consumption. Corn will yield from 25 to 60 bushels per acre and cotton from one-third to three-fourths bale per acre, according to seasons and methods of management. Little attention has been given toward conserving or increasing the fertility of this soil and the yields depend on the innate producing power of the soil. No systematic rotation of crops is practiced and little fertilizer is used. The natural productiveness of this soil seems in many cases almost inexhaustible. Instances were noted where cotton had been grown continuously on the same field for twenty-five years, maintaining a yield of one-half bale to the acre, without the addition of any organic matter or mineral fertilizers during the entire period. The practice of cultivating this soil to the clean-culture crops, like cotton and corn, year after year, is responsible in part for its stiff, tenacious nature. A rotation of crops, including a legume every few years to be plowed under, would tend to loosen up the soil and also tend in other ways to make the fields more valuable for the staple crops. It is advisable to plow this soil deeply in the fall, 10 or 12 inches, and to practice frequent and

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shallow cultivation during the growing season. This method would prevent any serious erosion, tend to conserve the soil moisture in case of summer droughts, and break down the compact soil structure.

This limestone soil appears to be eminently adapted to the growing of forage crops, especially alfalfa, sweet clover (*Melilotus alba*), and Johnson grass. The growing of alfalfa will no doubt be found profitable and will unquestionably take its place as one of the staple crops. In this connection live stock and dairying could be made important industries. For alfalfa the land should be well drained, free from weeds, and the seed bed thoroughly prepared. It appears that the entire section is well inoculated; but if it is not, a sprinkling of earth from a seeded area will meet the requirements. Often a fair dressing of lime is advisable prior to seeding, as leaching may have removed most of the original lime content of the immediate surface. While Johnson grass grows well, lands are seldom seeded to this crop, because it is more or less a pest in cotton and corn fields. Melilotus is indigenous to the soil and is found growing over most of the uncultivated areas.

The Houston clay is probably the strongest upland soil of the area and has a value of from $25 to $75 an acre, according to location and conditions of improvement.

The following table gives the average results of mechanical analyses of samples of the soil and subsoil of this type:

Mechanical analyses of Houston clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19022, 19024.....	Soil.....	0.1	0.7	0.9	5.6	14.1	56.9	21.6
19023, 19025.....	Subsoil.....	.0	1.2	.9	7.7	11.9	50.4	28.1

HOUSTON CHALK.

The soil mapped as Houston chalk is developed in the area to a very limited extent. It represents exposures of the more or less disintegrated Selma chalk formation of Cretaceous time. The exposures are the result of rather severe erosion, and they naturally occur on the slopes of the more rolling lands and along the escarpments of the larger stream courses. The accumulation of soil in such places is largely prevented by continual washing. There may be here and there a few inches of loose grayish-white material on the surface, but not enough to allow the growing of crops. When the accumulation is sufficient to create a surface soil, erosion is less severe and the color of the soil becomes darker; in such cases the material becomes the Houston clay.

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Cultivation of the Houston chalk is impossible, as the areas are invariably deeply gullied. Such areas can be reclaimed and fitted for cultivation by adapting methods to hold the weathered material in place until a soil can be produced, and this perhaps can be best accomplished by growing Melilotus. This plant will flourish on the exposed limestone, and when thickly seeded tends to check considerably the processes of erosion. The only profitable utilization of such areas is in growing this forage crop.

TRINITY CLAY.

The soil of the Trinity clay, to a depth of from 8 to 15 inches, is a very dark-gray to black clay loam or clay. The subsoil is of a lighter color, generally drab to gray, though the darker color may sometimes extend to a depth of 3 feet. Occasionally along a stream course that marks the boundary of the limestone formation the lower depths of the soil section may show a brownish color, owing to the fact that reworked material from the limestone has been mixed with other material which is a residual product of the underlying formation.

The Trinity clay is stiff, tenacious, and plastic when wet. On drying, the surface bakes hard and cracks. It is generally much darker in color than the Houston clay, owing no doubt to the presence of much organic matter.

The Trinity clay occurs only in the western part of the county, along the stream courses which flow through the limestone areas. It holds a marginal position along the channels of both the large and small streams, and has a comparatively level topography. Over the depressions and broad level valley lands natural drainage is often inadequate, and ditches are necessary to carry off excess water.

Like the Houston clay, when handled at the right moisture content the present type responds in a good tilth; but when plowed too wet it breaks in clods that are broken down with difficulty, and when plowed too dry the same difficulty is experienced in procuring a well-pulverized seed bed. If plowed deeply in the fall or winter an excellent structure is secured for spring and summer cultivation.

The Trinity clay is a derivative soil from the Selma chalk formation. It is reworked material. Found only in depressions or as marginal strips along stream courses, it represents the weathered product of the Selma chalk which has been transported from the surrounding elevations through the action of surface waters or which has been taken into suspension and deposited along stream courses during seasons of excessive rainfall and overflow. The type is largely subject to inundation during the rainy seasons of the winter months.

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A phase of the type, found in two areas, one along Tallabinnela Creek and the other near James Creek in connection with the limestone wash, consists of from 6 to 10 inches of a rather heavy silt loam of a grayish-brown to dark grayish color. It has a rather level topography, and drainage is naturally inadequate. This phase is derived from the wash material from the surrounding elevations and that transported in suspension and deposited during overflows. The reworked material is largely from the limestone areas, though there is some silty material from the Oktibbeha soils.

Being a very productive soil, most of the Trinity clay is under cultivation and generally planted to cotton and corn. Corn produces from 40 to 75 bushels and cotton from one-half to three-fourths bale to the acre without any fertilizers. The soil seems to be well suited to forage crops. Many areas support a luxuriant growth of Johnson grass, but as this crop is controlled with difficulty, it practically precludes any frequent rotation and is not very popular. When well seeded it yields from 2 to 4 tons to the acre, and the farmer should expect to let it run for several years. When the soil is well drained alfalfa will do well, but owing to the danger from floods over a large part of the type and the consequent drowning of the plants it is not recommended for this crop, especially as there is an abundance of upland prairie soil that is better suited to the habits of the plant.

While this soil contains some organic matter from the wash of the surrounding elevations, its stiff, intractable nature could be advantageously modified by the incorporation of more organic matter in the shape of roots and stubble plowed under. A good mechanical or physical condition of the soil is no doubt the most essential factor in securing high yields. Good drainage, deep plowing in the fall, and frequent shallow cultivation during the summer season would do much to equalize the yearly crop returns, as it would tend to prevent any severe distress to crops either in wet seasons or in droughts.

The soil has a value of from $10 to $60 an acre, according to location and conditions of improvement.

The following table gives the results of mechanical analyses of samples of the soil and subsoil:

Mechanical analyses of Trinity clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19056	Soil	0.0	4.2	2.2	11.3	4.5	39.3	38.7
19057	Subsoil	.0	2.9	1.3	13.5	7.1	36.8	38.4

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OKTIBBEHA CLAY.

The soil of the Oktibbeha clay, to a depth of 8 to 12 inches, is a brownish to reddish-brown clay, often approaching a clay loam in texture. The first inch or two of the surface soil, especially over the more level areas, has a very silty texture, but this quickly passes into the reddish clay. The subsoil is a mottled gray, yellow and red or brown clay, very plastic and tenacious, with a small content of the finer grades of sand. The red mottling decreases with depth, owing to diminishing agencies of aeration and oxidation. The more hilly or rolling the surface, the better the aeration and oxidation; hence the redder phase of the type found in such areas. The Selma Chalk formation is generally found at 3 to 10 feet below the surface, with occasional exposures showing the brownish clay resting directly on the limestone.

This soil is a heavy plastic clay, very compact, and intractable, and cultivation is carried on with more or less difficulty. The greater proportion of the area is still timbered with a growth of hardwood and some pine.

The Oktibbeha clay occurs chiefly associated with limestone soils, and is found only in the western half of the county, being largely confined to the outer edge of the prairie belt. Its most extensive occurrence is between the prairie lands and the later deposits giving rise to the more hilly and sandier soils to the east, though limited bodies may occur in the Houston clay area. This soil is very clearly distinguished from the Houston clay by the timber growth of hardwood which seems to be indigenous thereon, the Houston clay supporting no timber growth at all. The more rolling areas of the Oktibbeha clay often show a thin mantle of the Lafayette formation on the crests of the hills or ridges, and it is quite probable that in some instances the reddish coloring of the type has been imparted through the influences of this latter formation. The topography, as a whole, varies from gently rolling to comparatively level, with drainage generally good except over the more level areas. Owing to its close, compact, sticky nature the soil is not especially productive, and the yields are generally low. Deep plowing, affording a better aeration and oxidation, and the incorporation of organic matter in the shape of roots and stubble will tend to loosen up the compact clay and render it more friable. Areas that are cultivated from year to year, with due regard to improving mechanical condition, show it to be a soil that may be worked into good tilth.

This soil is derived from a calcareous laminated clay of Cretaceous time, which is included broadly in the Selma Chalk formation. There is such a great difference between the soil material (Houston clay) weathered from the typical Selma Chalk and the Oktibbeha clay weathered from this argillaceous shale that it is quite impossible to

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give them the same origin. While the Selma Chalk formation may, geologically, include the material giving rise to the Oktibbeha clay, it is quite probable that the latter represents a later deposit than the Selma Chalk, having been laid down while the lime rock was yet submerged. On the other hand, it is an older formation than the Lafayette, which is often found capping some of the higher elevations.

On the cultivated areas fair yields of cotton and corn are produced. The soil has a value of from $10 to $40 an acre.

The following table gives the results of mechanical analyses of the soil and subsoil:

Mechanical analyses of Oktibbeha clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19006	Soil	0.0	1.3	0.6	5.4	7.3	42.9	42.2
19007	Subsoil	.1	1.0	.5	5.4	10.5	46.2	36.2

The following samples contained more than one-half of 1 per cent of calcium carbonate ($CaCO_3$): No. 19006, 15.53 per cent; No. 19007, 11.39 per cent.

OKTIBBEHA SILT LOAM.

The soil of the Oktibbeha silt loam is a gray to brownish-gray heavy silt loam 6 inches deep. The texture often approaches a clay loam, especially where the surface is subject to any noticeable erosion. The subsoil is a mottled gray, yellow, and red or brown clay, heavy and plastic, gradually passing at lower depths into a material of practically the same nature, but with less of the bright mottling. This soil is cultivated with less difficulty than the clay type, though it requires care to prevent the soil material from running together.

The topography is gently rolling to comparatively level, with the more level areas predominating. Drainage is often sluggish and artificial methods have to be employed. The native timber growth is hardwood, though there is often a sprinkling of pine.

In origin and process of formation the type is similar to the Oktibbeha clay. The easy relief, precluding any severe erosion, has permitted the accumulation of a gray, silty surface soil, with more or less organic matter, and this has caused enough difference to justify the separate type name. This soil is found only in the western part of the county over the calcareous clayey deposit of Cretaceous time, from which the Oktibbeha series of soils is derived.

Cultivated areas of the Oktibbeha silt loam are used for the staple crops, cotton and corn, with the other common farm crops and vegetables grown in limited quantities for home consumption. Yields are poor to good, depending on the methods of cultivation and the conditions of improvement. In its unimproved state the soil has a very low agricultural value, but it can be profitably util-

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ized through proper handling, as it responds to cultivation quite readily. Being a heavy, fine-grained material, if allowed to stand long in level areas without stirring, the soil becomes very compact, until there is absolutely no aeration, no oxidation, or any of the conditions that make for plant growth. The soil needs to be stirred deeply and given an abundance of organic matter. Cowpeas, melilotus, rye, etc., sown broadcast and plowed under, would tend to make the soil more open and loamy and increase its value. In the more level areas open ditches from 4 to 8 feet deep are necessary to remove the surplus water. Land of this type of soil has a value of $10 to $40 an acre.

The following table gives the average results of mechanical analyses of samples of both the soil and the subsoil:

Mechanical analyses of Oktibbeha silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19010, 19012	Soil	0.0	0.6	0.7	11.3	18.7	57.1	11.2
19011, 19013	Subsoil	.0	.7	.5	7.1	16.4	44.9	30.1

OKTIBBEHA CLAY LOAM.

The Oktibbeha clay loam consists of a brown to reddish-brown silty clay to clay loam 9 inches deep, grading into a heavy, plastic, mottled red, yellow, and gray clay. The brighter mottling of the subsoil decreases with depth, owing to less aeration and oxidation. Over the comparatively level areas is found a somewhat more loamy surface soil, with an appreciable amount of silt, and here it often approaches a decided gray in color. This soil possesses many of the characteristics of both the clay and the silt loam members of the series, representing as it does a material slightly heavier than the silt loam and lighter than the clay. It is cultivated with more or less difficulty, being quite heavy and sticky when wet and hard when dry. When broken in clods, some difficulty is experienced in pulverizing them.

The Oktibbeha clay loam is found in areas of varying sizes, but always in connection with the other Oktibbeha types. There are several areas about 8 miles south of Nettleton, several about 6 miles west of Aberdeen, and several south of Aberdeen, west of the Tombigbee River, all of which are closely associated with the prairie or limestone soils. The topography varies from rolling to level, with drainage fairly good, though some of the more level areas need to be drained. The soil being fine-textured and compact, moisture percolates through it very slowly; hence the need of supplying arti-

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ficial outlets for excess rainfall, otherwise the soil will maintain a cold, clammy nature for days at a time.

The Oktibbeha clay loam is derived from the same material and through the same processes of formation as the Oktibbeha clay and the Oktibbeha silt loam. There have been modifications in local areas through the action of erosion, transportation of soil material, and the deposition of later material, like the Lafayette, thin mantles of which are yet in evidence on some of the higher elevations.

The agricultural value and crop yields of this soil are about the same as for the Oktibbeha clay, and the recommendations for that type will apply to this one. A good mechanical condition of the soil is a prime requisite for good crop yields, and this must be brought about through deep plowing and the incorporation of organic matter, by means of applications of stable manure or the plowing under of deep-rooted cover crops. The timber growth is chiefly hardwood and much of the type is as yet uncultivated. It has a value of $8 to $30 an acre.

The following table gives the results of mechanical analyses of samples of the soil and subsoil:

Mechanical analyses of Oktibbeha clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19008	Soil	0.0	1.3	1.3	7.8	2.4	57.6	30.0
19009	Subsoil	.0	.8	.9	7.9	4.1	38.5	47.7

OKTIBBEHA FINE SANDY LOAM.

The soil of the Oktibbeha fine sandy loam is a grayish to grayish-brown fine sandy loam 6 to 10 inches deep, and underlain by a rather heavy plastic sandy clay of a light-brown to yellowish-brown color, which at lower depths is usually mottled. Usually the surface few inches of soil has a slightly darker color, on account of the presence of decayed organic matter, this condition being quite noticeable in the untilled areas and in those of lower lying position. A few years' cultivation will invariably decrease the humus content. The subsoil is less porous and less friable than the subsoil of either the Norfolk fine sandy loam or the Orangeburg fine sandy loam, though it approaches the general character of the Norfolk subsoil, more especially in the more elevated and better drained areas. The mottling of the subsoil has not as great a proportion of red as is found in the heavier members of the series, the general scheme of mottling consisting of gray, yellow, and brown or reddish brown.

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Being a light soil and with usually good natural drainage, it is handled easily in cultivation. When very wet, however, the plastic nature of the upper subsoil render plowing, where the surface material is shallow, undesirable at such times, though the type as a whole is capable of cultivation over a wide range of moisture conditions.

This soil is found in one small area in the southwestern part of the county, along the Clay County line, being continuous with larger bodies extending into that county. It occurs in close relation to the prairie sections of the country, and, like the heavier members of the series, is probably derived in a large measure from the clayey deposits of the upper strata of the Selma Chalk formation. This type appears to be less distinctly derived from this source, however, than the heavier members, and it is quite likely that the Yellow loam formation has had an influence in determining the character of this individual area.

The topography of the type is gently rolling and natural drainage conditions are usually good, though local depressed spots may require artificial drainage, open ditches being satisfactory. Though a large percentage of it is still uncultivated, some fields are used for the cultivation of cotton of which fair yields are obtained. Like all soils of this general nature, there is need of organic manures to maintain productiveness, as the virgin fertility is soon reduced by the continued growing of clean-culture crops. The type responds readily to fertilizers, and with the addition of green or stable manures and a plan of crop rotation the soil can be made quite productive.

OCKLOCKNEE LOAM.

The Ocklocknee loam varies more or less widely in texture, structure and drainage features. The surface material ranges from a rather heavy sandy loam to a clay loam or clay, with a subsoil varying accordingly. These different characteristics, or phases, of the type occur so irregularly in varying sized areas that a detail separation was impossible. Certain small areas possess the characteristics of Meadow, but the agricultural value of the larger proportion of the soil forbids its correlation as Meadow. The character of the soil depends largely on the material of the surrounding elevations and of the region through which the streams have flowed, and the color is influenced largely by the color of the geological formation supplying the soil material, or by conditions of drainage and aeration. The presence of more or less organic matter in places imparts a darker color to the surface material. The surface soil of the lighter or sandy phase ranges in color from gray to yellowish-brown, and the subsoil from brownish to mottled gray and brown, while the heavier silty or clayey phase varies from gray to grayish-brown in the surface soil, and from brownish-gray to mottled gray and yellow in the

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subsoil. Cultivation is comparatively easy, especially in case of the sandier phases. The heavier phases can not be cultivated over such a wide range of moisture conditions, though any clods that may form are quite easily reduced with a light harrow. Ordinarily the soil breaks into good tilth, possessing the nature of a mellow loam.

The Ocklocknee loam occurs as marginal strips of varying widths along the many small streams of the area, with the exception of those flowing out of the prairie or limestone areas. The topography is usually level and the natural drainage inadequate. Artificial drainage is generally provided by open ditches. The stream channels are usually deep enough to afford a ready outlet for all necessary secondary ditches. Over the heavier phases, which occupy the level to depressed areas, a complete system of drainage should be established. The main ditch should run with the lowest contour and the secondary ditches should finger off in needed directions and at necessary intervals. Good drainage means increased crop yields.

This type of soil is a reworked material washed from the surrounding elevations through the action of surface waters or taken into suspension by the stream waters, transported, and deposited during seasons of overflow. Much of it is still subject to inundation and the planting of crops is often delayed on this account.

Like all bottom soils that receive continually wash material from the broad upland areas and frequent alluvial deposits, it is when well drained and properly handled very productive. Cotton and corn are the staple crops, and the yields are usually good, cotton producing from ½ to 1 bale and corn from 30 to 60 bushels to the acre. Oats, sorghum, melons, etc., give good returns. The soil carries a value of $10 to $30 an acre.

LUFKIN CLAY.

The soil of the Lufkin clay consists of a dark-grayish to brownish gray clay loam from 2 to 4 inches deep, containing a rather high content of silt. This material is underlain by a more yellowish or brownish subsoil to a depth of 10 to 12 inches, when it becomes a mottled gray and yellow or brown clay, which is clammy, heavy, tenacious, and impervious in character. A small proportion of the type where it adjoins a stream bottom may have a slight covering of transported material. In general, the type grades into other soils, chiefly the Oktibbeha and Houston series, without any clearly defined boundaries, though the gradation zone is not very broad. The more level silty areas show the grayer color, while in the better drained gentle slopes or knolls the color is a yellowish-brown. Very little of the type is under cultivation on account of its refractory and obdurate nature.

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The Lufkin clay is found only in three or four areas, chiefly to the west of Aberdeen, and in connection with the "flatwoods" and the "post-oak" lands. The topography is very gently rolling to flat, and drainage is usually very poor. The soil being of fine texture and compact, water moves through it very slowly and frequent drainage lines will be necessary for profitable cultivation. The cold, clammy, sticky, compact nature of the soil is induced, partly at least, through its flat topography and inadequate drainage.

Occupying about the same relation to the Houston clay formation as the Oktibbeha soils, it doubtless represents a derivative material from the argillaceous deposit on top of the Selma Chalk, the Lufkin characteristics being the result of its low-lying position and inadequate drainage.

By far the greater part of this soil is covered with a timber growth of hardwood, which constitutes its chief value. Development of the areas for agriculture is in general hardly practicable at the present time, as there is an abundance of good soil that can be prepared for profitable cultivation with much less expense.

The results of mechanical analyses of soil and subsoil are given in the following table:

Mechanical analyses of Lufkin clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19032	Soil	0.0	1.9	1.6	8.6	6.4	44.0	37.3
19033	Subsoil	.2	1.0	1.3	6.5	9.3	36.8	44.4

LUFKIN SILT LOAM.

The soil of the Lufkin silt loam consists of a rather heavy gray silt loam 6 to 8 inches deep, containing very little sand larger than fine sand. The subsoil from 6 to 15 inches is a yellowish material, heavier in texture and structure than the overlying soil, while the remaining depth to 36 inches is usually a mottled gray and yellow silty clay. Both the texture and color of the subsoil show variations usually dependent upon topography, the more level areas having the grayer coloring and the gently rolling areas the yellower phase. At lower depths the subsoil is invariably a stiff, heavy, plastic mottled clay. The surface material for a few inches shows a slightly darker color than that beneath, owing to the presence of varying amounts of decayed organic matter. Areas of this soil grade almost imperceptibly into other soils, though the lines of separation can be fairly well drawn.

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The Lufkin silt loam is found to the west of Aberdeen in areas of varying sizes and always in connection with other Lufkin soils or with the Oktibbeha series, which is also true of a single area about 5 miles west of Nettleton. The areas immediately around Amory, largely to the east and southeast of the town, occur chiefly in connection with the Cahaba silt loam. Owing to its rather limited extent the type is of little importance in the agriculture of the county. The topography varies from very gently rolling to comparatively level, with drainage fairly good over the more rolling stretches. In the depressions or more level areas where drainage is often sluggish open ditches are needed. These latter areas are usually more silty than the typical soil.

To the west of the Tombigbee River the soil appears to be a derivative from the formation giving the clay member of the series, probably influenced by some later deposit or transported material, while the areas around Amory appear to be derived from the formation giving the Cahaba silt loam, though such areas have been so influenced by moisture conditions that they possess the distinguishing characteristics of the Lufkin soils.

A part of the Lufkin silt loam is under cultivation and the yields of crops are fairly good. Cultivation can be carried on over a fairly wide range of moisture conditions, although when plowed too wet the soil tends to break into clods. These clods can be easily pulverized, however, by light harrowing, and as a whole the type may be readily put in good tilth. On account of the moisture-absorbing capacity of the clay subsoil and its rather impervious nature, drainage is necessary to secure good crops. Under good drainage conditions it is a desirable soil for general farming crops. Complete drainage, deep plowing, and the incorporation of organic matter in the form of barnyard or green manures are recommended. Cotton and corn are the chief crops grown, corn being confined largely to the lower lying areas.

The principal timber growth is hardwood on the areas to the west and pine on those to the east. The type has a value of $5 to $25 an acre.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of this type:

Mechanical analyses of Lufkin silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19028	Soil	0.4	0.4	1.2	13.5	17.5	59.5	7.2
19029	Subsoil	.2	.3	.9	10.8	11.1	44.9	31.7

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MYATT FINE SANDY LOAM.

The Myatt fine sandy loam consists of a light-gray fine sandy loam 6 to 10 inches deep, underlain to a depth of 36 inches or more by a mottled yellow, gray, and drab heavy fine sandy loam or sticky sandy clay. The suface soil usually contains varying amounts of silt, and the color ranges from a dark-gray to yellowish. The first few inches of soil are usually darker than the material below, on account of the presence of some decayed organic matter in the former. The upper subsoil is usually a yellowish sandy clay, passing into a heavier mottled gray and yellow clay at lower depths. This soil is cultivated with more or less difficulty on account of excessive moisture. The more rolling areas are better drained and more easily handled.

The type occurs in a few small areas in the vicinity of Aberdeen and Amory, to the east of the Tombigbee River, its entire extent being approximately 3 square miles. The topography is usually quite level and the drainage very poor. It occurs in connection with the Lufkin silt loam and Norfolk fine sandy loam, probably being derived from the same formation as the Norfolk type, and represents the depressed and poorly drained areas.

Very little of this type is given to cultivation, these areas being first drained by a system of open ditches. Cotton is the chief crop, and fair to good yields are produced. Like all sandy soils, there is generally a deficiency of organic matter. A rotation of crops, including a leguminous cover crop, preferably cowpeas, plowed under every two or three years, would conduce to increased crop yields.

The standing timber growth consists chiefly of pine, with some hardwood. The type has a value of from $5 to $20 an acre.

The following table gives the results of mechanical analyses of samples of both the soil and the subsoil of this type:

Mechanical analyses of Myatt fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19026	Soil	0.0	0.5	1.6	60.1	7.9	19.0	10.7
19027	Subsoil	.0	.1	1.3	46.5	6.4	17.9	27.8

ORANGEBURG FINE SANDY LOAM.

The soil of the Orangeburg fine sandy loam consists of 8 to 14 inches of gray sandy loam, in which the sand content consists largely of the grade of fine sand. The subsoil, to a depth of 36 inches or more, is a red to brownish-red sandy clay. The clay stratum varies in thickness, as is evidenced in road cuts, where a substratum of sand, or sometimes of sticky bluish clay, may be seen. Iron concre-

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tions are often found scattered over the surface soil and in the subsoil, and in the northeastern part of the county ferruginous masses were found on some of the hills. A few small areas of the type, too small to indicate on the map, show a rather high percentage of rounded gravel, and seams of gravel from 3 to 6 feet thick often outcrop on the slopes of many escarpments. The surface of large fields of the Orangeburg fine sandy loam show spots of a reddish to brownish color, the result of an admixture of material from the subsoil, which has been partially exposed by erosion. Such areas, when large enough, were mapped as the Orangeburg clay, though many small areas of the clay loam, and in one or two instances the sandy loam, were included in the fine sandy loam type. As the latter soil is of loose structure, it is easily handled and permits cultivation over a wide range of moisture conditions.

The Orangeburg fine sandy loam occurs uniformly in the eastern half of the county, where it occupies mainly the rolling to hilly divide extending across the county from north to south and separating the Tombigbee Valley from that of the Buttahatchie River. Over this broad expanse may be found small areas of various soil types, a great many of which were too small to show on the map. In the northern part of the county, in the forks of the Tombigbee River and Old Town Creek, are a few square miles of this soil, which is probably a continuation of that developed extensively in Itawamba County. To the west of the river, a few miles south of Aberdeen, the type occurs in a narrow strip of rolling country that flanks the river and extends to the southern boundary.

The topography varies from rolling to hilly, with drainage at all times good. While the soil is loose and open, permitting a ready absorption of rainfall, the surface is liable to damaging erosion, and in tilling care must be exercised to prevent washing.

The Orangeburg fine sandy loam is derived from the Lafayette sands and clays, deposits of Quaternary time. Local agencies of modification or an admixture of certain amounts of later deposits may have influenced the color of some areas of the type, still its greater extent is characterized by the red coloring of the Lafayette formation. The hilly topography of much of this soil, especially in parts of the divide, lowers its agricultural value. As a rule, it is a good soil and is cultivated in the staple crops, cotton and corn, with fair to good returns. Cowpeas, oats, sorghum, vegetables, and the usual farm crops are grown for local needs. The type is easily handled, responds readily to fertilizers, and is susceptible of great improvement. The sandy clay subsoil readily absorbs moisture and retains it for the growing crops.

This type of soil is well adapted to fruits, berries, grapes, etc., peaches doing remarkably well. Probably a good grade of tobacco could be

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grown on favorable areas. Truck crops would be profitable where the type is convenient to transportation facilities, and probably the more hilly areas could be best utilized in the production of fruits. The yield of cotton is from one-third to three-fourths of a bale to the acre, and of corn from 12 to 40 bushels, according to soil conditions and management. Adequate tillage methods and the use of winter cover crops to prevent washing, together with a systematic plan of rotation, including a cover crop, preferably a legume, to be plowed under every two or three years, would make this a stronger and more productive soil.

Much of the Orangeburg fine sandy loam type supports a timber growth of hardwood and shortleaf pine, which constitutes the chief value of certain very broken areas. The type ranges in value from $3 to $25 an acre, according to improvements or the quality of the standing timber.

The following table gives the average results of mechanical analyses of samples of the soil and subsoil of this type:

Mechanical analyses of Orangeburg fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19042, 19044	Soil	0.4	3.6	4.2	52.2	8.7	24.4	6.1
19043, 19045	Subsoil	.1	2.1	3.3	37.1	6.4	17.7	33.4

ORANGEBURG CLAY.

The Orangeburg clay is a brown to reddish-brown clay loam to sandy clay 6 inches deep, underlain by a reddish-brown to red sandy clay subsoil 36 inches or more deep. The sand content is chiefly of the finer grades, though occasional areas were encountered which showed a predominance of the coarser grades. The sand content varies; where the percentage is high the soil material is quite friable and where low it is sticky. In the more loamy areas there are appreciable amounts of silt mixed with the sand and clay. The type is less easily handled than the Orangeburg fine sandy loam, though when cultivated at the right moisture content it assumes a good tilth.

The Orangeburg clay does not occur extensively nor uniformly in this county, only a few square miles being mapped. It is found only in small areas and at irregular intervals in connection with the fine sandy loam type. The origin of the two soils is the same, both being derived from the Lafayette formation. The occurrence of the clay is due, in the main, to the action of erosion in transporting the sandy surface material and exposing the underlying sandy clay

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stratum. The coarser sand particles being less easily moved have remained and thus constitute a larger percentage of the sand content than they do in the sandy loam type.

The topography of the Orangeburg clay is rolling, though several small areas of the more loamy phase were found with a gently rolling surface. Ordinarily it is developed only where erosion is active. Drainage is at all times good.

This type of soil is cultivated chiefly in cotton and corn and fair to good yields are produced. It is a strong soil and when handled properly gives satisfactory returns. It has about the same value as the Orangeburg fine sandy loam.

NORFOLK FINE SANDY LOAM.

The soil of the Norfolk fine sandy loam is a gray to brownish-gray sandy loam 8 to 10 inches deep, in some instances approaching a loam. The subsoil is ordinarily a yellow sandy clay, though occasionally it may have a marked silty texture and vary in color from a brownish gray to mottled gray and yellow. The presence of more or less decayed organic matter gives the first few inches of soil a slightly darker color than that immediately below, this being especially true in the lower lying areas where leaching is less active. On the upper slopes of the elevations the brownish colored material is generally in evidence, while the lower slopes usually show the phase with the deepest surface soil. Being a light soil, cultivation is carried on with little difficulty, except over areas where drainage is deficient. Ordinarily the soil can be plowed without bad effects over a wide range of moisture conditions.

The Norfolk fine sandy loam occurs chiefly over the undulating to rolling portion of the county between the usually broad and comparatively level terraces of the Tombigbee River and the more rolling to hilly divide of Orangeburg fine sandy loam to the east, where it is found at irregular intervals in areas of varying sizes. Occasionally the rolling stretches will extend almost to the river channel. In the northwestern part of the county in the vicinity of Nettleton and to the north of Old Town Creek several square miles were mapped.

Surface features of the type range from undulating to rolling, with drainage ordinarily good. The more rolling areas have excellent natural drainage and the soil is fairly productive. It is susceptible of great improvement. The lower lying areas may be deficient in drainage, and in such cases open ditches prove satisfactory and less costly than tile. Over these latter areas is found the heaviest phase of the type and more consistently the mottled yellowish subsoil. Such areas, however, represent a small acreage and are of little importance.

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The Norfolk fine sandy loam is probably derived largely from the Columbia deposits of Quaternary time, with possibly some few small areas showing a percentage of material that obscurely indicates the individual area to have been remotely influenced by river action, such small areas occurring closely associated with the Cahaba fine sandy loam occupying the old river terraces. No doubt some of the type near the Orangeburg soils has been influenced by the Lafayette material, more especially where erosion has effected a removal of much of the overlying material. Such instances are evidenced by the brighter tint of coloring in the subsoil. The Lafayette sands and clays, however, can not be said to have contributed in any appreciable extent to the formation of this soil.

Though the larger proportion of the type is still unreclaimed to cultivation, it might be made one of the desirable soils of the area. It is easily handled, is well drained, has a wide range of crop adaptations, and shows a capacity for improvement. Being a friable soil, it can be handled at almost any time; and in the event of being plowed too wet, any resultant clods can be easily reduced by light harrowing. The type can profitably be devoted to the usual farm crops, care being exercised to maintain the fertility of the soil, which, being light, readily becomes impoverished of its organic content through indifferent and careless methods of cropping. Cotton, rye, cowpeas, and special crops, grown in rotation, with the cowpeas plowed under every two or three years, will do much to build up and maintain the productiveness of the soil. Some of the more level and heavier phases can be used for corn, though the type appears to be better adapted to cotton, peanuts, berries, melons, rye, cowpeas, truck crops, and probably certain varieties of tobacco. The usual method of fertilizing this soil is to apply commercial fertilizers, and their use is profitable. With fertilizers, used in connection with stable and green manures, and systematic rotation of crops there should be no difficulty in bringing this type of soil into larger account in the agriculture of the area. It has a value of from $10 to $20 an acre.

The following table gives the results of mechanical analyses of samples of the soil and subsoil:

Mechanical analyses of Norfolk fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19038	Soil	0.0	0.5	0.5	41.1	25.7	27.6	4.5
19039	Subsoil	.0	.4	.2	27.0	25.3	29.8	17.1

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CAHABA SILT LOAM.

The soil of the Cahaba silt loam is a gray silt loam 8 inches deep, containing some organic matter and varying quantities of the finer grades of sand. The subsoil is a yellowish clay loam to a depth of 18 inches, where it grades into a yellowish sandy clay. Occasionally the lower subsoil has a mottled appearance, owing probably to deficient drainage or the presence of certain iron compounds which on oxidizing stain the surrounding material. The color of the surface soil may be yellowish-brown to yellowish-gray, depending generally on the topographic relief. The more level areas show the more grayish color, owing largely to the presence of a higher percentage of organic matter. The subsoil is sometimes a very sandy clay and again a very heavy clay. It may be reddish or a very light and generally mottled color. These conditions, however, are limited, and the type runs rather uniformly with the typical light-gray to yellowish-gray surface soil, underlain by the yellowish to brownish-yellow sandy clay subsoil.

This is a very desirable soil, as it combines with a rather friable texture sufficient compactness to maintain a good moisture supply. The heavier phases may break into clods which tend to bake on drying but these are broken up with little difficulty, except where the soil has been plowed when entirely too wet, in which case clods may bake very hard.

The type occurs chiefly to the east of the Tombigbee River, though a few limited areas are found on the west side a few miles north of Aberdeen. Its extensive occurrence is over the undulating to gently rolling country between the lower river bottoms and the rolling divide of Orangeburg fine sandy loam to the east. It extends across the entire county from north to south in areas of irregular outline broken by many areas of other types of soil. Beginning at the county line near Smithville, it runs practically parallel to the Tombigbee River throughout its course to the junction of the Buttahatchie River.

The surface features are characterized by an easy relief, many areas presenting a comparatively level topography. Drainage is ordinarily good, though inadequate in some cases in the more depressed areas. There is generally a rather abrupt escarpment of several feet from the higher elevations to the stream bottoms or lower elevations. These escarpments generally exhibit outcrops of a seam of rounded gravel several feet thick and from 6 to 20 feet below the surface. No doubt this gravel underlies much of the type and is a great factor in bringing about the good drainage conditions.

The Cahaba silt loam is probably derived from the yellow loam of the Columbia formation of Quaternary age. No doubt a part of it has

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been transported from the adjacent hills and elevations which were at least partially covered by these deposits. Its very gentle surface precludes any severe erosion.

A wide range of crops may be grown on the Cahaba silt loam. It is easily managed, responds readily to fertilizers, has good drainage generally, and permits of the use of almost any kind of improved machinery. Some of the most progressive farming in the county is seen on this type of soil. Commercial fertilizers are used to some extent. A beneficial crop rotation and improved tillage methods are practiced and labor-saving machinery is used. Cotton and corn are the staple crops, though oats, rye, Irish and sweet potatoes, cowpeas, vegetables, fruits, etc., are successfully produced. Probably the lighter phases of the type would produce a good grade of tobacco. On an average, the soil will produce about one-half bale of cotton to the acre and from 20 to 35 bushels of corn, though yields of 1 to 1½ bales of cotton and 75 bushels of corn to the acre have been produced by some of the progressive farmers. The uncultivated areas support a timber growth of hardwood and pine. The type has a value of from $15 to $60 an acre, according to location and conditions of improvement.

The following table gives the results of mechanical analyses of samples of the soil and subsoil:

Mechanical analyses of Cahaba silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19034	Soil	0.2	0.8	2.2	13.9	5.4	67.0	10.6
19035	Subsoil	.3	.4	2.4	16.0	9.8	49.8	20.9

AMORY FINE SANDY LOAM.

The soil of the Amory fine sandy loam is a brown fine sandy loam 6 to 8 inches deep, often approaching the texture of a loam. It contains an appreciable percentage of silt and the sand content is mainly of the finer grades. The subsoil varies from a brown fine sandy loam to a sandy clay to a depth of 36 inches or more, but the color varies from yellowish brown to reddish yellow over local areas. The color of the subsoil, which also influences the surface appearance, was the distinguishing characteristic upon which its separation was based. In general, the type is quite similar to the Norfolk fine sandy loam and the Orangeburg fine sandy loam, but its color is too red to permit its classification with the Norfolk series and too dull to go with the Orangeburg soils. The surface material grades insensibly into

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the underlying sandy clay subsoil, there being no marked line of separation. The Amory fine sandy loam is a fairly strong soil and is cultivated with little difficulty. The heavier phases may be too heavy to handle when very wet, though generally the soil is friable and readily put in good tilth.

This type of soil occurs chiefly to the east of the Tombigbee River in comparatively level to gently rolling areas between the river terraces and the hilly divide in the eastern part of the county. It appears in scattered areas of varying size throughout the zone of the Norfolk soil. Many areas too small to indicate were included in the Norfolk fine sandy loam. The largest area is found about 6 miles east of Aberdeen, between areas of Cahaba fine sandy loam and Orangeburg fine sandy loam. This area, while continuous except for stream-bottom areas, is not uniform, as it includes small spots of other soil types, chiefly Cahaba silt loam.

The topography is gently rolling to comparatively level and the drainage is generally good. The slopes are generally moderate and the soil rather porous, so that little, if any, damaging erosion takes place.

The soil is no doubt derived from a material that is, at least in part, contemporary with that giving the Norfolk soil, but which probably has a slightly different chemical composition as regards its iron content, or the soil may represent an admixture of more recent material with the Lafayette formation. There are no definite lines of separation between this and adjoining types.

The Amory fine sandy loam has about the same agricultural value as the Norfolk soil which surrounds it. Cotton and corn are the chief crops, while sorghum, oats, melons, and peas are grown in limited quantities.

With a proper system of crop rotation and improved tillage methods this soil can be brought to a high state of productiveness. On the lighter phases, especially in the southern part of the county, the trucking industry might be made very profitable. Land of this type of soil has a value of from $10 to $30 an acre.

The following table gives the results of mechanical analyses of samples of both the soil and the subsoil:

Mechanical analyses of Amory fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19014	Soil	0.0	1.3	8.5	42.4	5.4	37.0	5.3
19015	Subsoil	.1	.7	5.5	30.0	6.4	36.3	21.3

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GUIN FINE SANDY LOAM.

The soil of the Guin fine sandy loam consists usually of a gray fine sandy loam 6 to 15 inches deep. The color of the shallowest phase, found generally on the upper slopes, is usually influenced by admixture with the underlying brownish clay. The presence of varying quantities of organic matter gives the first few inches of the soil a usually darker color than the underlying material. The subsoil is usually a yellowish-brown to yellowish-red sandy clay, though it may be almost any shade between red and yellow. The texture of the subsoil is also variable, ranging from a rather heavy clay to a very sandy clay, the heavier phases generally showing the reddish-brown color.

Areas of the Guin fine sandy loam are not uniform, as they include many spots of material showing different characteristics, but too small to indicate in the map. Small spots of Orangeburg material, more or less typical, or of Norfolk material may be frequently encountered. There appears to be no regular system of occurrence of these soils; they may develop on the crests of slopes of the hills, ridges, or over the more level areas. Generally, however, the material is of brighter color on the slopes, where a better aeration and oxidation is possible. The deepest soil is found on the lower slopes and in the narrow valleys. In some of the hills in the northeastern part of the county there occur small fragments and larger masses of ferruginous sandstone. Little of the type is under cultivation, though it is easily tilled.

The type occurs in the northeastern part of the county on each side of Splunge Creek and is the prevailing soil over the territory east of the Buttahatchie River. The topography is rolling to very hilly, the areas consisting of irregular ridges interspersed with narrow V-shaped valleys. Drainage is at all times good, the run-off being so rapid that erosion is severe.

The Guin fine sandy loam is probably derived from an intermingling of material of the Lafayette formation with some later deposits. The color of the subsoil is similar to that of the Amory fine sandy loam, being intermediate between the Norfolk and the Orangeburg. Probably in the northeastern part of the county the Tuscaloosa has entered into the formation of the soil.

Owing to the very rough topography, there are large areas upon which farming is impracticable and have the chief value of the land in the forests of hardwood and pine. In fact, the agricultural value of the soil as a whole is low, and the greater part of it remains in forests. The areas under cultivation are usually in the less rolling stretches, but even these are invariably subject to more or less severe erosion. Very probably fruits could be produced extensively on the

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hills and ridges, but the distance to convenient market facilities is a great handicap. The valley and lower lying areas, where sufficiently broad to justify cultivation, are given to cotton and corn with good returns. Commercial fertilizers are used. The region occupied by the Guin fine sandy loam is the most thinly settled part of the county, and until much more of the other farm lands is utilized the chief value of the type will continue to be the timber growth. At present it carries a value of from $2 to $20 an acre, depending largely on the character of the forest.

SUSQUEHANNA FINE SANDY LOAM.

The soil of the Susquehanna fine sandy loam consists of a gray to light-brown fine sandy loam, ranging in depth from 6 to 10 inches. The subsoil to a depth of 3 feet or more is a plastic red clay, containing considerable quantities of partially decomposed shale. Throughout the soil section are also found frequent deposits of fine quartzite gravel, and in the lower strata limestone fragments are occasionally encountered. Where the sandy material completely covers the stiff clay subsoil, the type is friable and easily handled, but where the heavy subsoil approaches the surface the material when wet is very sticky and plastic, making cultivation difficult.

Only a few small areas of the type are developed. These are found in the eastern part of the county. The areas are often so small that it was impracticable to show them on the map.

The type has a very hilly topography, being found only on the steep slopes in the rougher portion of the area. On account of this hilly condition the drainage of most of the areas is excessive and erosion has taken place to a damaging extent.

None of the type is under cultivation, the entire soil body being covered by a growth of red oak, post oak, black-jack oak, and hickory, and the growth of this native timber is probably the best utilization of the type.

The value of the Susquehanna fine sandy loam ranges from $3 to $7.50 per acre.

The following table gives the results of the mechanical analyses of samples of the soil and subsoil of this type:

Mechanical analyses of Susquehanna fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19046	Soil	2.1	1.7	2.0	18.0	26.5	40.6	8.8
19047	Subsoil	.0	1.1	.8	5.0	6.4	49.8	36.8

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OCKLOCKNEE CLAY LOAM.

The Ocklocknee clay loam consists usually of a dark grayish-brown to brownish clay loam 6 to 12 inches deep underlain by a lighter brown clay subsoil, usually quite heavy and plastic and occasionally mottled with iron stains at lower depths. The surface material carries in general an appreciable amount of silt, more especially in level and depressed areas. The gentle swells or better drained areas along the stream channels show the lightest phase of the type, with a sand content including all the grades, but with the finer predominating. The subsoil is usually a stiff, tenacious, light-brown to yellowish-brown clay, often mottled at lower depths and occasionally light gray in poorly drained areas. Some depressed areas were encountered in which a very dark-gray to almost black surface soil occurred. Cultivation is carried on with difficulty on account of the heavy nature of the soil, the unfavorable moisture conditions, and the frequent inundations.

This soil forms the first bottoms along the courses of Old Town Creek and the Tombigbee River. It is not continuous at all times along the stream channels, being broken by areas of other bottom types. Occasionally the stream channel has been cut deep enough to accommodate all rainfall, and where this is the case the soil lies above overflow. As the river bottoms are so thinly settled and support such a luxuriant growth of timber and underbrush, a detail traverse was considered impracticable. The lines of separation between the three divisions of these bottom soils were usually very indistinct, though in some instances there are well defined terraces.

The topography varies from comparatively level to flat, with drainage usually sluggish or poor. Numerous old sloughs traverse the type. These hold water for weeks or months after overflows and much of the rainfall drains into them. During the summer overflows are seldom and the soil becomes well drained, though not until long after the planting season. The river channel is usually deep enough to permit a good fall for artificial drains. Deep canals or broad ditches leading to the river channel would adequately drain large areas of this soil and fit them for profitable cultivation. There would of course be danger of overflow, but these occur only in the wet seasons of the winter or late spring. Occasional damage to crops might be expected, but as the soil is very fertile its use for certain crops would give good returns.

The soil is largely alluvial in origin, having been deposited by the river during seasons of overflow. As the heavier soil particles carried in suspension are the first to be deposited, the land along the river front has usually a loamy nature, often approaching a sandy loam, while the finer particles are deposited from the slow-moving

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or stagnant waters over the broad low-lying stretches farther away from the stream. The dark-grayish color of the soil, especially in certain areas, and its heavy nature are no doubt in part the result of material washed from the black-prairie (Houston) soils.

Practically all of the Ocklocknee clay loam is in forests, the timber being chiefly gum, and numerous lumber enterprises are located along the river. With the deforesting of this soil and the installation of good drainage systems, it will be found to be very productive. The yearly addition of an alluvial deposit is a guarantee of sustained fertility. The value of the type ranges from $5 to $20 an acre, depending largely on the grade of standing timber.

The following table gives the average results of mechanical analyses of samples of the soil and the subsoil of this type:

Mechanical analyses of Ocklocknee clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19052, 19054.....	Soil.....	0.1	1.9	2.1	23.2	9.1	38.1	25.2
19053, 19055.....	Subsoil.....	.0	.4	1.4	27.6	11.6	26.1	32.5

CAHABA LOAM.

The Cahaba loam consists of a gray light loam 4 to 10 inches deep, often approaching a fine sandy loam in texture underlain by a brownish to mottled yellow and gray heavy fine sandy loam to clay loam. The darker gray surface soil and the mottled subsoil are generally found in the lower lying to level areas. Most of this soil is under cultivation and is readily kept in good tilth.

This is a second bottom soil found along the Tombigbee River. It represents the oldest of the broad bottoms that bears evidence of alluvial origin and is no longer subject to overflow. The largest areas occur in the northern part of the county near the junction of Old Town Creek and the river. The topography is gently rolling or undulating to level, and the heavier phases of the soil are found in the lower lying areas, where the silt content is quite appreciable. The gentle swells are more loamy, owing to the transportation to lower levels of a part of the original silts and clays. Drainage varies from good to poor, according to topography, the low areas demanding rather extensive ditching.

The cultivated areas are used chiefly for cotton and corn, cotton yielding about one-half bale and corn from 25 to 50 bushels to the acre. Good drainage, deep plowing, crop rotation, and the addition of organic matter would build up a strong soil adapted to a wide variety of crops. Large areas are still in original forests, the timber

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growth being largely hardwood with a sprinkling of pine. The land has a value of from $5 to $30 an acre.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of this type:

Mechanical analyses of Cahaba loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19048	Soil	0.0	0.6	2.2	50.3	9.9	20.0	16.7
19049	Subsoil	.0	.1	1.5	35.5	7.9	18.9	35.7

OCKLOCKNEE SILT LOAM.

The soil of the Ocklocknee silt loam consists of a dark-grayish to yellowish-gray silt loam about 9 inches deep. The subsoil is a yellowish heavy loam grading into a rather heavy mottled gray and brown clay loam at lower depths. The dark color of the first few inches of surface soil is influenced by organic matter, the color becoming a rather light gray on thoroughly drying. The lighter phase of this soil occurs on the higher swells, where the material often approaches a fine sandy loam in texture, while the heavier phase is confined to the depressions and lower lying areas. Over the more level to depressed sections the subsoil has a grayer mottling than elsewhere. The larger proportion of the type is unimproved, but cultivated areas are friable and easily kept in good tilth. The heavier phase may break into clods when plowed, especially if plowed too wet, but these can be broken down without much difficulty with a light harrow. Some areas of the type approach the character of Meadow.

The Ocklocknee silt loam occurs as first bottom land and occupies the lower depressions of the valleys of Buttahatchie River, Sipsie River, and Splunge Creek. The boundary lines between this and the other bottom land type are often indistinct, especially in the Buttahatchie River Valley, and separations are necessarily arbitrary, except when distinct terraces occur. Many spots of undifferentiated material too small to map are included in the type. The topography is approximately level, with depressions or swells appearing at irregular intervals. Old sloughs are numerous. Drainage is a necessary prerequisite in cultivating most of the type, and valuable areas have been reclaimed to profitable agriculture through a system of canals or ditches leading into the river.

This soil represents in part material washed from adjacent slopes and in part that transported by the river and deposited during floods. It includes practically all of the present overflow land of the Buttahatchie drainage system. Many depressions or sloughs at

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higher levels, representing old drainage lines of the valley which remaining for years in swampy condition or covered with water, have been filled up through natural agencies sufficiently to be artificially drained and reclaimed to profitable cultivation.

The greater proportion of the type is in standing timber Where cultivated the yields are usually good, corn producing from 30 to 60 bushels and cotton from one-half to three-fourths bale to the acre. Commercial fertilizers are used. This is naturally a strong soil. A part of it is enriched annually by alluvial deposits. If properly drained and cultivated the soil would prove one of the strongest soils of the county. Crops might be occasionally damaged by floods, but the overflows occur only during seasons of excessive rainfall, and rarely during the growing season. The type has a value of $5 to $25 an acre.

CAHABA FINE SANDY LOAM.

The Cahaba fine sandy loam is a grayish fine sandy loam 6 to 12 inches deep, underlain by a yellowish to brownish sandy clay subsoil, which in many instances is mottled. The surface soil at times has a brownish tinge and is usually slightly darker in the first few inches on account of the presence of a larger quantity of decayed organic matter. The sand content is of the finer grades, and there is usually an appreciable amount of silt in both the soil and the subsoil. The color of the surface material is often determined by the position of the area, the lower levels and depressions invariably showing the darker gray color, while the more elevated areas and gentle slopes usually present the brownish coloring, leaching in this position being more rapid. The lower areas also have a higher content of silt. Except in areas where drainage is deficient, cultivation is comparatively easy, and the average yields are satisfactory, though they could be greatly increased by incorporating in the soil organic matter in the form of stable and green manures. The type is a rather loose and friable soil and can be plowed under a wide range of moisture conditions.

This type of soil occurs in irregular-shaped areas of varying sizes throughout the comparatively level country adjacent to the Tombigbee and Buttahatchie rivers and Old Town Creek. Along the Tombigbee River it occurs closely associated with the Norfolk fine sandy loam, Cahaba silt loam, and Amory fine sandy loam, these types occupying largely all the level to undulating country between the river and the hilly divide of Orangeburg fine sandy loam to the east. In the Buttahatchie River valley it occurs on some of the higher terraces which are usually adjacent to the uplands. Along Old Town Creek the small areas are found upon the oldest terraces of the valley lands.

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The surface features of the type range from level to undulating or very slightly rolling, and drainage is usually fair to good. Some lower lying areas are deficient in drainage, but that condition can usually be relieved by means of open ditches, the soil being sufficiently porous to permit a rather free percolation of water. While in some cases the type may occupy the high terraces immediately adjacent to the streams, its occurrence quite uniformly marks the outer edge of the valley lands.

While the material constituting this type of soil has many similarities of the Norfolk fine sandy loam, its position, its manner of formation, and its consequent agricultural value forbid its correlation with the Norfolk series. In a great many instances its separation from the Norfolk soils was quite arbitrary. The type, occurring as it does over the broad flats flanking the larger stream courses of the area, no doubt represents material that was subjected to river action in remote time, but which to-day so obscurely retains the characteristic evidences of reworked material as to make it a difficult matter to locate boundaries definitely. The river flats are often 4 or 5 miles wide and there are in general well-defined terraces to mark the older and the younger river deposits. Still this type occupies the position, quite clearly marked in some instances, of the oldest river terraces. It occurs over the higher swells and knolls of the valley lands and is always beyond the reach of overflow waters. When occurring immediately adjacent to the uplands the type represents reworked material—the wash from the surrounding elevations mixed with old alluvium.

A large portion of the type is still uncultivated, though it is a very desirable soil. It is a light, friable soil, easily handled, retentive of moisture, responds readily to fertilizers, offers possibilities for a wide diversification of crops, and when rightly handled is of high producing capacity. Like all the sandy soils of the area, its fertility depends in a great measure on maintaining the supply of organic matter. In the absence of stable manure, a leguminous cover crop, preferably cowpeas, plowed under every two or three years, is recommended. Yields are ordinarily fair to good, averaging about one-half bale of cotton and from 20 to 40 bushels of corn to the acre. Much larger yields have been produced by progressive farmers. In addition to the usual farm crops of cotton and corn, hay, oats, cowpeas, rye, and special crops could no doubt be grown very profitably. The type, in part at least, could be used for truck crops, peanuts, berries, melons, and probably for tobacco. Stable and green manures receive a ready and lasting response from this soil, and if liberally used will bring the type to a high state of productivity. Commerical fertilizers are largely used and with paying returns. The type has a value of from $10 to $30 an acre.

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The following table gives the average results of mechanical analyses of samples of the soil and subsoil of this type:

Mechanical analyses of Cahaba fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19016, 19050	Soil	0.0	0.8	2.2	35.8	21.2	34.4	5.2
19017, 19051	Subsoil	.1	.2	.6	17.7	16.1	41.7	23.1

SUMMARY.

Monroe County lies in the northeastern part of the State of Mississippi in the first tier of counties along the Alabama line and about 65 miles south of the Tennessee border. It comprises 487,040 acres, or 761 square miles. The topography ranges from rolling to undulating or comparatively level. The two principal drainage lines are the Tombigbee River, flowing across the central portion of the county from north to south, and the Buttahatchie River flowing in the same general direction through the eastern part and emptying into the Tombigbee at the southern edge of the county.

The settlement of the area is fairly general, more marked, however, over the more productive soils and in the neighborhood of the railroads and towns. A large part of the area is under cultivation and yields range from fair to good. The timbered hilly sections in the east and the low-lying, poorly drained areas in the valleys of the larger streams represent the lands of lowest agricultural value at present.

Aberdeen, with about 5,000 inhabitants, near the center of the county, is the county seat, and the most important town of the county, while Amory in the north with a population of 1,500, is a thriving business place.

Four systems of railroads operate in the area; the Frisco, in the northeastern section, the Mobile and Ohio in the western, the Illinois Central in the southern, and the Aberdeen and Tombigbee Valley, which crosses the central part in a northwest and southeast direction. Ample transportation facilities are convenient to all sections. Rural mail delivery routes and telephone lines are universal.

Climatic conditions are favorable to a diversified agriculture. The winters are mild and short and the summers long and comparatively hot. The rainfall is well distributed throughout the year, with the highest average during the late winter months.

Cotton and corn are the staple crops grown, with oats, wheat, sorghum, melons, peanuts, potatoes, vegetables, fruits, berries, cowpeas, alfalfa, Johnson grass, melilotus, etc., produced in sufficient

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quantities to meet local needs. The introduction of alfalfa in the black prairie region and its successful culture bids fair to make it one of the staple crops of the limestone section. Commercial fertilizers are used extensively on the lighter sandy soils. No general system of crop rotation is largely practiced and little recognition is given to the adaptation of soils to crops. Negro labor is largely used and proves satisfactory under supervision. The monthly wage is about $15.

Twenty-two types of soil were established in the area, varying in texture from sandy loams to clays. Large areas still support a forest growth of hardwood and pine.

The Houston clay is probably the strongest upland soil of the area for general farming purposes. Cotton, corn, and forage crops are the chief products, cotton yielding from one-half to three-fourths of a bale and corn from 30 to 75 bushels to the acre. Johnson grass, alfalfa, and melilotus are the chief forage crops, with yields ranging from 3 to 6 tons to the acre. The type has a value of $20 to $50 an acre.

The Houston chalk represents exposures of the limestone formation, resulting largely from erosion. The growing of melilotus is the most profitable utilization of these areas, as well as the best method of reclaiming them to cultivation.

The Trinity clay is a black heavy bottom soil of the prairie areas, and is subject to overflow. It is a strong soil for cotton, corn, and forage crops, cotton producing from one-half to 1 bale, corn from 40 to 75 bushels, and hay, chiefly Johnson grass, from 3 to 6 tons to the acre. It has a value of from $25 to $60 an acre.

The Oktibbeha clay loam is a somewhat lighter soil than the clay, and slightly more friable, though its agricultural value and possibilities are about the same.

The Oktibbeha silt loam where well drained produces fair to good crops. Drainage, deep plowing, and the incorporation of organic matter to modify its compact nature are necessary requisites for successful crop production on this soil.

The Ocklocknee loam is a productive soil found along the courses of the smaller streams. It is usually cultivated to cotton and corn with good results. Much of it is above average overflow, while portions of it are inundated frequently. It has a value of from $10 to $30 an acre.

The Lufkin clay, owing to its compact, impervious nature, and deficient drainage, is undesirable for farming, though when well drained fair to good yields of cotton and of corn are produced. Little of the type is under cultivation, the remaining areas supporting chiefly a growth of hardwood.

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The Lufkin silt loam is well adapted to a variety of crops when thoroughly drained, and the value of the Myatt fine sandy loam as a farm soil depends largely on the efficiency of drainage. The greater proportion of the latter type is in timber.

The Orangeburg fine sandy loam, which is found in the rolling to hilly sections in the eastern part of the county, is adapted to a wider range of crops. It can be easily brought to a high state of productiveness. The soil is cultivated to cotton and corn as the staple crops, with oats, sorghum, vegetables, and fruits as supplementary crops. It has a value of from $5 to $30 an acre.

The Orangeburg clay appears in small areas, its occurrence being largely the result of erosion in removing the sandy surface soil and exposing the red sandy clay subsoil. It is a strong soil when properly handled, yielding from one-half to three-fourths bale of cotton and from 30 to 60 bushels of corn to the acre.

The Norfolk fine sandy loam is a desirable soil both for general and for special farming. It shows great capacity for improvement. On this soil corn yields from 30 to 60 bushels and cotton from one-half to three-fourths bale to the acre. Oats, wheat, sorghum, vegetables, melons, fruits, and forage crops do well and probably tobacco would be a profitable crop. This soil has a value of from $10 to $30 an acre.

The Cahaba silt loam is one of the desirable extensive soils of the area and is adapted to a wide diversity of crops. About the same crops are grown on this soil as on the Norfolk fine sandy loam, and good yields are obtained. It has a value of $15 to $60 an acre.

The Amory fine sandy loam is associated in origin and position with the Cahaba and Orangeburg soils, and has about the same agricultural value as the Cahaba fine sandy loam.

The Guin fine sandy loam is largely timbered with hardwood and pine. When cultivated it is devoted to the growing of cotton and corn with fair to good results. It has a value of $2 to $20 an acre.

The Ocklocknee clay loam represents the first bottoms and lower depressions of the Tombigbee River Valley. Much of the type is subject to yearly inundation and supports a heavy growth of gum and other hardwoods. Extensive ditching will be necessary to develop this soil.

The Cahaba loam occurs on the second bottoms or terraces. It is generally slightly elevated above overflow and some of it is cultivated in cotton, corn, and sorghum, all of which give satisfactory yields. Most of the type needs better drainage and a large part is still timbered in hardwood.

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The Ocklocknee silt loam is an alluvial soil much of which is subject to overflow. Its timber growth is chiefly hardwood. The soil is naturally fertile and when cultivated good yields are obtained. Much of it needs draining. It carries a value of $5 to $25 an acre.

The Cahaba fine sandy loam represents the higher terraces of the river bottom. The type is cultivated chiefly to cotton with good results. Commercial fertilizers are used. Truck, peanuts, potatoes, and fruits would no doubt be successful crops. The type has a value of $5 to $25 an acre.

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SOIL SURVEY OF BIENVILLE PARISH, LOUISIANA.

By THOMAS A. CAINE, E. B. WATSON, THOMAS D. RICE, W. J. GEIB, W. S. LYMAN, and H. L. BELDEN.

DESCRIPTION OF THE AREA.

Bienville Parish is located almost wholly in the shortleaf pine hill section of northwest Louisiana, between the Red and Mississippi rivers, about 40 miles east of Shreveport. A small portion of the

FIG. 21.—Sketch map showing the location of the Bienville Parish area, Louisiana.

southern part of the parish is located in the longleaf pine hill section. The parish lies approximately between parallels 32° 8′ 53″ and 32° 33′ 30″ north latitude and meridians 92° 45′ and 93° 25′ west from Greenwich. It is bounded on the north by Webster, Claiborne, and Lincoln parishes, on the east by Lincoln and Jackson parishes, on the south by Winn, Natchitoches, and Red River parishes, and on the west by Red River and Webster parishes and Lake

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Bistineau separating this parish from Bossier Parish. The thriving town of Arcadia, the parish seat, having a population of about 3,500, is located in the extreme northeast corner, on the Vicksburg, Shreveport and Pacific Railway. Geologically, the parish lies in the Mississippi embayment, and the formations principally represented are within the Tertiary Eocene. There are 519,680 acres, or 812 square miles, in the parish.

The parish is well supplied with streams and branches. The headwaters of Black Lake Bayou, Saline Bayou, and some of those of Dugdemona Bayou start in Bienville Parish, and eventually the entire drainage of the area reaches the Red River through these streams. The parish slopes gradually to the southeast or south. In the northern part, upon the upper reaches of the drainage basins, the hills are higher and more broken than in the southern part. The highest altitude in the parish is about 450 feet, while along the southern boundary, where the streams cross the line, the altitude is about 100 feet, so that there is a range in elevation of about 350 feet within the parish. Very little fall is noticeable along the larger streams, which follow winding, tortuous courses through wide swamps. This lack of fall, together with the crookedness of the stream courses, causes the wide swamp bottoms to be submerged often during the winter months. The water in the small streams and branches, however, runs off rapidly. The interstream areas are often considerably eroded and dissected along the upper courses of the tributary streams, this being especially noticeable in the northern part of the parish. To the southward, however, the country flattens and the interstream areas are lower and less dissected. In the southern part of the parish the swamp areas along the larger streams become wider and more difficult to cross. The drainage of the interstream areas of low elevation is often poor, while to the northward, upon those of higher elevation, the drainage is, if anything, excessive. The drainage of the parish eventually reaches the Gulf of Mexico through the Red and Mississippi rivers.

No permanent settlement took place in what is now Bienville Parish until 1826, when a settlement was made on Black Lake Bayou, 4 miles west of Arcadia. Later, about 1839, another settlement was made at what is now Mount Lebanon. In 1843 Bienville Parish was organized from a portion of Claiborne Parish. The woods at that time were open, there being nothing but large timber and the whole country was covered with a growth of switch-cane, which formed extensive canebrakes in the bottom lands. There was an abundance of game, and hunting and fishing furnished much of the early settler's occupation.

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Some of the early military and immigrant trails to Mexico and Texas crossed the parish, and these old overland routes were the scenes of great activity, especially so when Texas was being colonized by Americans. In their westward journey across the country the immigrants, coming mostly from Kentucky, Tennessee, Georgia, the Carolinas, Alabama, and Mississippi, were attracted by the rich, productive red gravelly lands in the northern part of what is now Bienville Parish, and it was at this period that the region received its greatest number of settlers, many of the immigrants having given up their journey westward to Texas, while some of those who continued their journey returned later to take up lands for settlement.

The people who settled on the red gravelly lands in the vicinity of Mount Lebanon, Liberty Hill, and Arcadia established permanent homes. Those, however, who settled in the lower country in the southern part of the parish did not become permanently attached to the land, but moved from one locality to another seeking more favorable range for their hogs and cattle.

The present farming population of the parish is made up almost entirely of the descendants of these early immigrants and of the descendants of the slaves brought in by them. In the northern part of the parish, where slavery was most common, about 25 per cent of the farming population is composed of negro property owners and tenants. Many of the white farmers have acquired considerable wealth and have rented their farms and moved to town. In some of the northern parts of the parish the houses in the country are neat and substantial and the farm buildings commodious. Good churches and schools are convenient to all. The roads are excellent in summer, but in winter they are apt to become badly cut up and in places almost impassable. The population around the larger railway towns has greatly increased, owing to the lumber interests and railway construction. A large percentage of this increased population is made up of colored people, while the increased white population comprises mostly people from Arkansas, Missouri, and Tennessee.

It is estimated that about 50 per cent of the land in the northern part of the parish has at one time or another been under cultivation. There are considerable areas, however, that were once farmed but are now abandoned, either from lack of labor or because the white owners have moved to town. In this part of the parish much of the land is farmed by negroes, who either own the land or work as tenants. Wherever the red gravelly soils are found the country is well settled and cotton is the main product. The roads are well kept, and many of the larger streams are bridged. The rural free delivery of mail is well established and the telephone enters many homes.

In the southern part of the parish, however, where the soils, as a rule, are much less productive, the conditions as to settlement are very

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different. Not more than 10 per cent of the land has ever been under cultivation, and the remainder is still in virgin forests or has been recently cut over. The recent activity in lumbering and the high prices paid for timber lands have induced some to leave their farms to engage in day labor about the sawmills, and others to dispose of their entire holdings to the lumber companies. The result has been that in some localities fields once cleared are growing up to brush and briers, and farmhouses, once the homes of thrifty farmers, are unused and tumbling down. The roads in this part of the parish are poorly kept, and only the larger stream crossings are bridged. There is no rural free delivery of mail and the telephone is as yet practically unknown, except about the towns, mills, and logging camps.

About ten years ago there was much public land in the parish, but since timber has become more valuable this land has been rapidly acquired, principally by the large lumber companies, so that at present there is none.

All crops are fenced and stock is permitted to run at large, there being no stock law in the parish.

Arcadia, Gibsland, Taylor, Bienville, and Saline, all located on railways, are the chief towns of the parish. Mount Lebanon and Liberty Hill are the principal towns not on railways. The parish is crossed by several railways, which furnish, as a whole, excellent transportation facilities. The Vicksburg, Shreveport and Pacific Railway crosses the northern part of the parish, passing through Arcadia, Gibsland, and Taylor, and connecting them with Shreveport on the west and Ruston, Monroe, and Vicksburg on the east. The Louisiana and Arkansas Railway crosses the southwestern corner of the parish and brings the farmers into communication with such markets as Winnfield and Shreveport. The Louisiana and Northwest Railroad crosses in a north and south direction, passing through Gibsland, Bienville, and Saline, and furnishing connections with the Texas and Pacific Railway at Natchitoches on the south and with the Cotton Belt Route at McNeil on the north. Besides these, there are two important tram railways, which will be used eventually for passengers and freight. Portions of the southeastern part of the parish are about 15 miles distant from a railway, but this distance will be lessened when one of the tramroads becomes a passenger and freight line.

CLIMATE.

The climate of Bienville Parish is best described as temperate, with an average annual temperature of 65.5° F. During the coldest months, December, January, and February, the mercury seldom goes below the freezing point for more than two or three days in succession. Owing to the high humidity, however, freezing weather is

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usually felt with greater severity than farther north or west, where the air is drier.

Spring opens the latter part of March or the first of April, during which months the fields are prepared and planted. The average date of the last killing frost in the spring is about March 25, but truck and fruit, and the tender cotton and corn plants are occasionally injured as late as the first week in April. The summer months, June, July, and August, have an average temperature of about 81° F. After this the weather begins to cool gradually until the latter part of October, when light frost may be expected. The average date of the first killing frost in the fall is about November 15.

The precipitation of the area is usually abundant for all growing crops. For all months of the year except August, September, and October the rainfall is distributed at the rate of 4 or 5 inches per month. It is not always well distributed during the month, however, but sometimes comes in torrents, which cause much damage to the cultivated fields by washing and gullying. During August, September, and October the rainfall decreases to an average of less than 3 inches per month, and although the main part of the growing season is over, crops sometimes suffer from drought.

The appended table, compiled from Weather Bureau records, gives data of temperature and rainfall at Shreveport, situated in Caddo Parish, about 40 miles to the east, and at Liberty Hill, within the parish. They show the annual precipitation to be about 50 inches, and the average annual temperature to be, as above stated, about 65.5° F. The length of the growing season is especially favorable to the production of cotton and corn and all root crops and vegetables, especially Irish and sweet potatoes, two crops of the former often being grown upon the same ground in a single season. Considerable difficulty is experienced with the peach crop. During the progress of the survey, peach trees were seen in bloom as early as January 27, and by the middle of February a good many peach and plum trees were in bloom. On February 20 there was a heavy frost, and an examination showed that about one-half of the blooms were killed. On March 3 peaches and plums were in full bloom. The usual warm days which occur during the late winter and early spring months cause the fruit trees to bloom long before they should, and this, together with the fact that the region lies within the track of "northers," makes the growing of some kinds of fruit rather uncertain. However, peaches are said to be an abundant crop on an average of about every third year, which compares favorably with results in some of the most successful peach-growing sections of the country. Occasionally there is a cold, wet, late spring and the seed cotton and corn do not germinate, which necessitates replanting; but this, considering the long season, is not a serious drawback.

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Normal monthly and annual temperature and precipitation.

Month.	Liberty Hill.		Shreveport.		Month.	Liberty Hill.		Shreveport.	
	Temperature.	Precipitation.	Temperature.	Precipitation.		Temperature.	Precipitation.	Temperature.	Precipitation.
	° F.	In.	° F.	In.		° F.	In.	° F.	In.
January	47.6	4.94	45.9	4.60	August	82.3	2.83	81.3	2.19
February	49.5	4.19	51.2	4.16	September	75.6	2.95	75.5	3.73
March	58.1	5.61	57.6	4.64	October	66.3	3.02	65.3	3.11
April	65.9	4.64	66.4	5.20	November	56.3	4.13	54.6	4.78
May	73.3	3.39	73.1	4.19	December	49.2	4.75	49.5	4.68
June	79.8	5.06	79.9	3.79					
July	82.4	4.87	82.5	3.53	Year	65.5	50.38	65.2	48.60

AGRICULTURE.

The first settlers chose the "red lands" in the northern part of the parish, because they had been accustomed to similar lands in the older States whence they came, and they recognized that these soils were more productive than the light-colored, sandy soils in the region to the southward. Those who settled to the southward, however, did so with a special purpose. They preferred stock raising to general farming, and here they found numerous wide swamps with extensive canebrakes, besides many other conditions favorable for the raising of hogs and cattle.

A good many of the settlers brought with them a few slaves, and with the aid of these they constructed for themselves log houses and barns, deadened the timber, and built fences and planted their crops. At first each settler strove only to produce enough corn, fruit, tobacco, vegetables, and meat to supply domestic needs. All crops were fenced, the cattle branded, and the hogs marked and allowed to run at large in the woods and swamps. In the northern part of the parish the hogs and cattle raised were largely consumed at home, while to the southward, where the settlements were sparse and stock raising was the chief industry, there was always a surplus. This surplus was disposed of in winter by driving the hogs and cattle to shipping points on the Red and Ouachita rivers, and from ten days to two weeks were usually consumed in the journey. Some sheep were also kept, and upon the plantations much time was spent in winter in spinning and weaving cloths for home use. Each plantation was practically self-sustaining and sometimes existed as a community by itself. Large plantations, however, were not the rule, as most of the early settlers did all of their own work. Whatever surplus was produced upon the farms besides stock was hauled to market by ox teams. There was much cotton grown around Liberty Hill and Mount Lebanon and farther north around Arcadia and Gibsland

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before any railway entered the parish. In fact, cotton was then the staple crop, as it is now, but not so much was then grown. It was marketed mostly at Trenton, a shipping point about 3 miles north of Monroe, on the Ouachita River. Some of the larger cotton planters dealt directly with commission merchants in New Orleans. Most of them, however, shipped from Trenton and a few shipped from a point on the Dorcheat about 2 miles from Minden known as "Chrichten's Landing." The production of cotton proved profitable upon the "red lands," and as early as 1860 considerable wealth had accumulated about Arcadia, Liberty Hill, and Mount Lebanon.

The Vicksburg, Shreveport and Pacific Railway was the first to enter the parish. Though it had been in operation between Vicksburg and Monroe as early as 1857, it was not extended westward through Bienville Parish to Shreveport until 1883. The completion of this road did much toward stimulating the agriculture of the area.

To-day the principal products besides cotton are corn, potatoes, vegetables, small fruits, and forest products. Among the farm products corn stands next to cotton, but there is great opportunity and need of expansion in growing corn to supply the unsatisfied local demands. The potato crop has not as yet assumed any great importance, but it bids fair to do so in the future. Both sweet and Irish potatoes do remarkably well and two crops of the latter can be grown upon the same piece of ground in a single year. The vegetables grown are mostly those for home use. In the vicinity of Gibsland a few farmers are growing some peaches and vegetables for canning. Thus far a ready local market is easily found for all they can produce. The canning industry has great possibilities in Bienville Parish and it is believed that eventually the small individual canners will consolidate.

In the southern part of the parish the forest products exceed all others combined. It is believed that at the present rate of removal of the pine timber it will be less than twenty years before much larger areas will be put under cultivation, thereby greatly increasing the agricultural production of the parish.

It is generally recognized that the "red lands" are well adapted to cotton and corn and to nearly all vegetables and small fruit common to the region. It is believed that by selecting elevated portions of ground, so as to avoid the losses due to frost, peaches will prove a profitable crop. Considerable difficulty is experienced, however, in getting peach trees to live more than six or seven years, and in order to overcome this trouble there are some who set out a few trees every two years or so. A fine grade of tobacco can also be grown upon these "red lands," but the farmers are so engrossed with the

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production of cotton that none are growing tobacco on a commercial scale.

The settlers in a good many places in the southern part of the parish did not at first locate permanently, and frequently moved from one locality to another. The importance of acquiring possession of the land and timber either by homesteading or by direct purchase from the Government did not impress them. The necessity of having to pay taxes caused many to have an aversion to acquiring legal possession, and until recent years there were many families who had lived in the parish for forty or fifty years and had never owned any land. The great difficulty of making clearings and the rapidity with which they grew up when neglected or abandoned caused many people to regard the timber as a hindrance to their progress. The great value of the pine and oak forests was not appreciated until about twenty years ago, when northern lumbermen appeared and began to pay from $2 to $3 an acre for the land and timber. Since then there has been a steady advance in prices paid, until some of the same land is now held at from $25 to $40 an acre.

The great amount of labor employed about the railway and logging camps and sawmills has created an unsatisfied demand for all kinds of farm products, and the result has been to stimulate agriculture throughout the area. The most progressive farmers are trying to satisfy the increased local demands for poultry and eggs, vegetables, fruit, and meat. Stock raising, and especially hog raising, in the southern part of the parish has decreased considerably, largely for the reason that with the cutting of the oak timber for the manufacture of staves the supply of mast has been greatly reduced.

It is generally recognized that the sandy upland soils, especially the red sandy gravelly soil, are better adapted to cotton than to corn. The reverse, however, is true of the bottom-land soils, for there the best yields of cotton are obtained from the heavier soils, while the corn yields best upon the lighter soils. Cotton seems to thrive best upon either a heavy soil or upon a sandy soil with a heavy subsoil not far below the surface. Sweet and Irish potatoes and all kinds of small vegetables do best upon the sandy upland soils. The highest gravelly ridges are the best for peaches, and in the early days a good grade of tobacco was grown for home use in such locations. Sorghum and sugar cane do best where an abundance of moisture is assured, and usually this is upon the small branch-bottom soils or the second bottoms of the larger streams which are not subject to serious overflow. It is believed that alfalfa would thrive upon the heavy clay upland soils, provided the drainage conditions were made perfect. It does not do well upon the sandy soils, because the weeds and grass kill it out. Alfalfa has been tried on a small scale by

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sowing and cultivating it in rows, in order to keep down the weeds and grass, but this is not considered profitable by those who have tried it. In general, it may be said that the soils of the area are well adapted to all of the general farm crops of the region.

There is practically no systematic rotation of crops practiced in the area, cotton often being grown continuously upon the same land until the fields have become so badly washed that the yields decrease to a point where it is no longer profitable to grow crops, and then the field is usually abandoned to grow up to brush and weeds. The acreage of corn is so small, as compared with cotton, that the general type of farming may be considered a one-crop system.

Shallow one-horse plowing is the common practice upon light and heavy soils alike, and for all cultivated crops, regardless of drainage conditions, location or kind of soil, the fields are broken in ridges. No green manuring is done and practically none of the barnyard manure is applied to the fields. In winter nothing is done to protect the bare fields from the damaging effects of leaching and erosion. The result is that both the bottom and the upland soils, especially the latter, rapidly lose their original productivity, and instead of building up and maintaining the fields already cleared, the farmers, in order to maintain the cotton production, usually bring new or fresh land under the plow every few years and allow the old fields to gully and wash and become reforested.

Of the 519,680 acres in the parish over 300,000 acres are in farms, and the remainder is either in timber or swamp lands. The number of acres in improved farm lands, however, is, according to the census report of 1900, only about 110,000 acres, or less than one-fourth of the entire area of the parish.

There are no very large plantations in the parish. Most of the farms are small and about 60 per cent of them are worked by the owners, the remainder being worked by both negro and white tenants. There are a good many negro property owners in the northern part of the parish and some of them are thrifty and prosperous.

The average size of the farms is about 125 acres. The holdings, however, range from a few acres to several thousand, and some of the larger timber concerns own more than 20,000 acres.

The price of cleared and improved agricultural land varies with the location and character of the soil and the condition of the fields and the farm buildings. The average price in the hill section, where the "red lands" predominate, varies from $10 to $25 an acre, while the light sandy soils, in the southern part of the parish, range in price from $5 to $15 an acre. The timber land varies greatly in value according to the location and the amount of merchantable timber standing. Where the land and timber are purchased together the prices range from $8 to $40 an acre; where the timber is pur-

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chased alone, with an agreement to remove it in a specified number of years, it is estimated and sold by the thousand feet, the price ranging from $1 to $3 a thousand feet, depending largely upon the accessibility of the timber to market.

Throughout the area the problem of farm labor is a serious one. Most of the laborers who were formerly available have gone to the public works, and many of the small farmers have sold their timber and cleared land to the lumber companies and have gone to the logging camps and sawmills, being attracted thither by the high wages.

There is much to be said in the way of suggestion for the improvement of the agriculture of the area. One of the greatest losses sustained by the farmers is from the washing and gullying of the fields during the growing season and also during the winter months, owing to the fact that the fields are kept too long in clean cultivated crops, thereby greatly reducing the amount of organic matter that was originally in the soil. This loss of organic matter and the shallow cultivation that is usually given the soil greatly increase the tendencies to erosion. To remedy this, rotation and deep plowing are recommended. The rotation suggested as best suited to the conditions in Bienville Parish is cotton one year, followed by corn, and then by winter oats as soon as the corn is gathered. Cowpeas should be sown between the corn rows at the last cultivation, and if the succeeding oat crop is allowed to mature the ground should be disked as soon as the oats are harvested and again sown to cowpeas. Deep plowing (that is, to a depth of 7 or 8 inches) promotes soil granulation and the capacity of the soil to hold moisture. A thorough preparation of the ground is half of the cultivation. Some farmers complain that whenever the ground is broken to a depth of 7 or 8 inches the unweathered soil thus exposed does not produce well for a couple of years or so. This may be avoided by gradually increasing the depth at each plowing until the required depth is attained. Winter plowing is a good practice, as it exposes the soil during the winter months and subjects it to the pulverizing action of frost and rain. If the plowing is not done in the fall it will be well to bring up only a half inch or so of the subsoil at a time, but this should be increased at each plowing until a depth of at least 7 inches is reached.

On the well-drained sandy types of soil, not steep enough to be subjected to serious erosion, the soil should be broken flat with a disk plow instead of in high ridges. If the land is inclined to wash seriously this can often be prevented by terracing. With deep plowing, even if the natural conditions favor washing and gullying, these tendencies will not be so great, because deep plowing promotes soil granulation, and much of the water which would naturally run off over the surface will be absorbed, which, in addition to checking

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erosion, is beneficial, as in droughty times this moisture will be available for the needs of the growing crops.

In places where terracing would be beneficial much good can often be accomplished by breaking the land in high ridges that circle the hill. This will arrest the direct descent of the waters over the surface, and prevent their gathering in dangerous volumes, for each row will carry off its own water. Where the slopes are especially steep zones of plowed land should be alternated with strips of grass or shrub land. Upon the close sticky soils like Susquehanna clay and Greenville loam, and upon the bottom-land soils where water is inclined to stand after a heavy rain or flood, the fields should never be broken flat, but in high ridges. Upon such soils, and especially the bottom lands, tile drainage would be very beneficial and desirable, but often fair drainage can be obtained by large open ditches. An open drain at the base of the hills to carry off the rainwash from above is often important in connection with the drainage of the bottom-land soils.

Another very desirable practice in connection with the thorough preparation of the soil is fall plowing, and the advantages of this are many. The air is allowed to penetrate the soil, and alternate freezing and thawing have a tendency to loosen up the compact stiff soils, thus putting them in better tilth and insuring a better seed bed for the next crop. During the winter months much of the inert plant food is broken down, dissolved, and converted into a form available for plants the next year. Another desirable effect of deep, careful fall plowing is that it enables the soil to absorb and store up the winter rains, thus placing at the disposal of the plant roots for the next year a larger quantity of moisture, and mitigating in this way the effects of the droughty conditions which may prevail from the middle of July to the middle of September. In order to derive the best results from fall plowing upon the heavier types, however, they should be tile drained; otherwise the soil will be inclined to run together and pack, thus increasing its tendency to bake.

If care is not taken the fall-plowed lands will wash badly during the winter months. In order to avoid this the growing of winter cover crops, such as the rust-proof oats, crimson clover, wheat, hairy vetch, and the dwarf Essex rape, is strongly recommended. On the light sandy soils the oat crop is the safest grain crop that can be grown, and if the ground is broken deeply in September or October sufficient moisture will be saved to insure a stand, and the oats will furnish an abundance of winter grazing for stock. If the stand is good and the oats are on good land, grazing will not injure them, but will actually improve the yield. Wheat sown upon good land furnishes a winter pasture nearly equal to oats. The yield of grain, however, is not reliable.

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Crimson clover should be sown early for winter grazing. It attains the best growth for grazing during the spring. It is not advisable to cut crimson clover as a hay crop, however, because it is too woody, but being a legume it has great value as a soil builder. Crimson clover should do best upon the heavier clay types, but the drainage conditions will have to be improved before the best results can be attained. Hairy vetch is also a legume and is a very satisfactory winter cover crop upon the lighter sandy soils. The land, however, must be well prepared and well manured.

All winter cover crops more than pay for themselves in the excellent grazing they afford, and if the land is needed for cotton or corn before they mature the farmers can well afford to turn them under in the green state in February to add vegetable matter to the soil.

In recent years a great deal of commercial fertilizer is being used on the cotton crop, especially along the Vicksburg, Shreveport and Pacific Railway, in the northern part of the parish. There is a fertilizer factory at Arcadia which is not able to supply the local demands. The results of using this fertilizer, which is composed of about equal parts of cotton-seed meal and acid phosphate, seem thus far very satisfactory, but it is believed that by pursuing a systematic crop rotation and by following the recommendations and suggestions as to deep plowing and the growing of winter cover crops the heavy outlay made for commercial fertilizers can be greatly reduced.

The recent appearance of the boll weevil in this section of Louisiana is causing the farmers a great deal of anxiety. It is believed, however, that the pest is proving a blessing in disguise, because the uncertainty of the cotton crop is persuading the progressive farmers to diversify more, and instead of growing all cotton and buying everything with cotton money, they are beginning to plant more corn and less cotton, and grow more of the home necessities. Some, however, are convinced that cotton can be grown in spite of the boll weevil. They are basing their convictions upon what has been done in parts of Texas, where the weevil has been for years.

The most successful method of combating the weevil and the one advocated by Doctor Knapp, of the Bureau of Plant Industry, and his agents in this section of the State is as follows: First, reduce the acreage and grow cotton as a surplus crop, and not as the main money crop. Prepare the soil thoroughly and plant early. Growing cotton under boll weevil conditions really resolves itself into a race between the farmer and the pest. The weevils do not appear in great numbers until July, and if the farmer can get his cotton sufficiently far advanced before that date he will be able to make a crop. In order to accomplish this the ground should be broken

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deeply and thoroughly pulverized, as this thorough preparation hastens maturity. An early-maturing variety should be selected, and it should be planted in rows far apart, so as to insure an abundance of sunshine upon the entire cotton plant, for shady, damp conditions are especially favorable for the weevil. Frequent, shallow cultivation should be the practice in order to hasten the growth of the plant, and in passing between the cotton rows it is well to attach a short stick to each end of the whiffletree, so as to shake the cotton stalks as much as possible without injury. This knocks off the loose punctured bolls, as well as many of the weevils, a number of which immediately perish in the hot sand. It is best to gather up the punctured bolls and burn them. In the fall the cotton stalks should be gathered and burned. All of the surrounding fences should be kept clear of brush and briers, which furnish a place for the weevils to hibernate.

All of this requires much labor and attention, but if cotton is grown as a surplus only, a few acres will be grown where now many are grown, and it is safe to say that double the yields per acre can easily be obtained.

SOILS.

The soils of Bienville Parish fall naturally into three groups—those of the rolling uplands, of the level or moderately rolling lowlands, and of the swamps.

The rolling uplands include all of the higher portion of the parish and range in altitude from about 350 feet in the highest points to about 150 feet in the lowest. The surface features vary from rolling to hilly. The soils are residual in origin, being derived principally from the Lower Claiborne formation, a subdivision of the Eocene. The highest elevations in the area, however, are sometimes capped by the Lafayette sands. The Lower Claiborne formation is composed of numerous thin layers of fine sand, silt, and clay, some of the layers being semiconsolidated with iron, forming iron sandstone and iron claystone, iron conglomerate, and concretions in great numbers. In the highest parts of the area the crests of the ridges are sometimes so thickly strewn with these ferruginous rocks as to interfere with cultivation, and in the cultivated fields the tops of the hills are often covered with the small iron concretions.

The soils of the rolling uplands belong principally to two series, the Susquehanna and the Greenville, the latter being derived from the more ferruginous layers of the Lower Claiborne, and the former from the clayey and sandy layers of this formation. The uplands are usually well drained and include some of the best soil types in the area.

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The level or moderately rolling lowlands occur principally in that portion of the parish below an altitude of about 150 feet. The soil types belonging to this division, however, are found more or less developed adjacent to all of the main drainage courses in the area. The characteristic topography is gently undulating to nearly level, and the natural drainage is deficient. The soils are sedimentary in origin, being derived principally from the Port Huron deposits, though in places the sands of the Lower Claiborne formation have contributed to the soil-forming materials.

The swampy soils have been mapped as Meadow, which is of wide distribution, being found in practically all parts of the area, but especially well developed along the larger stream courses. These bottoms are flat and vary in width from a few rods to 2 miles. They are subject to frequent overflow. The wider bottoms are sometimes covered with water for weeks at a time, while the narrower ones often drain off in a day or so. The soil is still in the process of formation and is of heterogeneous origin, being washed from various sources in the uplands.

The following table gives the name and extent of each of the several types mapped. In the accompanying map the distribution of the soils is shown by means of colors.

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Norfolk fine sandy loam	152,576	29.4	Orangeburg fine sandy loam	12,288	2.4
Meadow	90,048	17.3	Orangeburg fine sand	10,880	2.1
Susquehanna fine sandy loam	88,960	17.1	Bienville fine sandy loam	5,888	1.1
Greenville gravelly sandy loam	64,000	12.3	Greenville loam	448	.1
Susquehanna clay	37,376	7.2			
Norfolk sand	32,256	6.2	Total	519,680	.....
Orangeburg sandy loam	24,960	4.8			

GREENVILLE GRAVELLY SANDY LOAM.

The soil of the Greenville gravelly sandy loam to a depth of 10 or 12 inches varies from a reddish to grayish fine sandy loam. Throughout the soil and strewn upon the surface are numerous arenaceous and argillaceous brown iron concretions about the size of a pea, and upon the crests of the higher hills crusts of brown hematite and limonite ore often occur in considerable quantities, though not sufficient to be of economic value or to interfere seriously with cultivation. The subsoil to a depth of 36 inches consists of fine iron gravel. The gravel in this soil, which is always of a ferruginous, concretionary nature, is never rounded and waterworn, as is usually the case

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with quartz gravel. There are often some fragments of iron crusts disseminated through the subsoil. At a depth of about 40 inches the subsoil sometimes becomes slightly mottled with drab, and resembles the subsoil of the Susquehanna fine sandy loam.

This soil is naturally an easy one to plow and cultivate, and the gravel and sand present tend to keep the tools well scoured and clean. It is locally known as "red sandy gravelly land," and has contributed largely to the reputation of this region and southern Arkansas for cotton production. The fields are usually free from stumps, and the soil has been under cultivation for a long time. Shortleaf pine and oaks were the characteristic native growth.

The Greenville gravelly sandy loam is particularly well developed in the northern part of the parish, upon the hills in the vicinity of Arcadia, Gibsland, and Mount Lebanon. It is also an important soil in the vicinity of Liberty Hill, and there are some large areas in the southwestern part of the parish.

The usual topography of this soil is rolling to hilly, and owing to this and to the somewhat open nature of the subsoil the natural drainage is good.

The Greenville gravelly sandy loam is derived from the weathering of sands and sandy clays of the Lower Claiborne formation, and the few ferruginous rock fragments found upon the surface have been formed from the hardening and cementing together of the sandy and clayey layers, and are not the fragments of indurated rock formations. The soil is characterized by its high content of iron, the presence of large quantities of iron concretions and iron crusts being evidence of this. The underlying unweathered material from which the Greenville soils are derived often consists of bluish, slightly greenish, and grayish marly sandstone, rendered firm and hard by the presence of carbonate of lime. All traces of this calcareous constituent is lost upon weathering and the iron turns the whole mass to a deep-red color. Upon the crests of the hills, where the fine sand and clay particles have been removed by rainwash, these concretions and small fragments of iron crusts are especially numerous and sometimes cover the surface of the ground to a depth of an inch or more.

When first cleared and put under cultivation the average yield on this soil was greater than now. The average yield for cotton is said to have been about three-fourths bale per acre, while that for corn was about 25 or 30 bushels per acre. Continuous cropping with cotton grown upon the same ground for years in succession has reduced the yields so that at present the average yield for cotton is about one-half bale, while that for corn is as low as 20 bushels per acre. Other crop yields have decreased in like proportion. It is an excellent soil for oats; these usually being fed in the sheaf.

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With careful preparation and cultivation the land is easily improved and retains very well all improvements in the way of additions of fertilizers. Worn-out fields on this type, if not too badly washed and gullied, are easily put into good condition by deep fall or winter plowing and the sowing of some winter crop, and by practicing the following three-year rotation: First, plant cotton and follow it with corn the next year. Cowpeas should be sown with the corn at the last cultivation. After the corn is gathered, plow about 7 inches deep and sow some good winter cover crop to protect the hills from washing and gullying during the winter and spring rains. If the winter cover crop is allowed to mature, cowpeas should again be sown after the cutting of the former. In reclaiming these old worn-out fields, cowpeas should figure largely in whatever rotation is followed, because they will not only add the most expensive fertilizing element, nitrogen, to the soil, but will add organic matter and open up the subsoil for aeration.

A considerable amount of commercial fertilizer is being used upon this type where cotton is grown year after year, and the tendency of the fields to wash and gully seems to be yearly increasing. One of the main reasons for this is the diminishing supply of organic matter, which has a tendency to bind the soil particles together. Raw commercial fertilizer should not be used alone year after year, and if used at all should be in conjunction with an abundance of organic matter. The best fertilizer is well-rotted stable manure, but in the present area this is in most cases allowed to go to waste. Rough barnyard manure is next to stable manure in value. Green manuring crops are also helpful to this type, but it is believed that some lime should be applied to the land either just before or immediately after the green crop is turned under. The commercial fertilizer used upon this soil is a mixture of equal parts of cotton-seed meal and acid phosphate.

This soil besides being well adapted to the staple crops of the region—cotton and corn—is also a good soil for Elberta peaches. By selecting the highest ridges on this soil it is believed that the danger from frost will be greatly lessened, and thus profitable crops would be secured with greater regularity. It is also believed that a fine grade of wrapper tobacco can be grown, as is the case on soils having similar characteristics in eastern Texas.

Owing to the desirability of this soil for general farming and the ease with which it is cultivated, it is nearly all cleared and under cultivation and well improved. For these reasons it is considered the most important agricultural soil in the parish. The average price of well-improved land with buildings varies from $15 to $30 an acre, depending upon the location and the character of improvements.

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The following table gives the average results of mechanical analyses of the soil and subsoil of the Greenville gravelly sandy loam:

Mechanical analyses of Greenville gravelly sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18659, 18661.....	Soil.....	2.0	2.1	1.6	47.1	15.6	25 0	6.7
18660, 18662.....	Subsoil.....	2.2	1.9	.9	30.9	8.7	16.1	39.1

GREENVILLE LOAM.

The Greenville loam to a depth of 3 to 6 inches consists of a reddish-brown or chocolate-brown very fine sandy loam or loam which usually contains an abundance of humus. The subsoil to a depth of about 30 inches consists of a brownish-red, friable, heavy clay loam, through which are usually disseminated appreciable quantities of very fine iron concretions, imparting a gritty feel. Below this the reddish material becomes slightly mottled with yellow, which mottling increases with depth and finally changes to drab. At a depth of about 5 feet the material consists of a drab and red clay, resembling the subsoil of the Susquehanna types at a depth of about 3 feet. The air and water are able to penetrate the Greenville loam freely to a greater depth than the Susquehanna soils; hence the above difference in color of the subsoils.

This soil only occurs in small areas and is associated with the Susquehanna clay, being in a way an intermediate type between the Susquehanna clay and the Greenville gravelly sandy loam. It is principally developed in the vicinity of Liberty Hill and also occurs in a considerable area at Gansville, in Winn Parish. The soil also occurs better developed in southern Arkansas, and in some of the Louisiana parishes bordering that State.

The characteristic surface features vary from nearly level to moderately rolling, and the drainage is fair. Artificial drainage would in many cases be helpful.

Under ordinary conditions it is a fairly easy soil to plow and cultivate. In the spring, however, it can not be plowed as early as the more sandy types, and special care must be taken not to plow the ground when it is wet, because the soil, if the plowing has been deep, will bake and dry in very hard lumps. It is locally known as "red land" or "mixed land," and is very highly valued for the production of cotton, corn, and oats. It is exceedingly well adapted to oats, but as they are always fed in the sheaf no definite idea of the yield of grain can be given. It is estimated that the yield would be over 40 bushels per acre.

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The Greenville loam is practically all under cultivation, having been cleared of the virgin forest growth, which consisted principally of oak and hickory, with some shortleaf pine. It is considered a very strong soil and easily maintains a high state of productiveness when once put in that condition. As only 0.1 per cent of the parish is occupied by this soil, it is of little local importance. The average price for land of this type, including farm buildings and all improvements, is about $20 an acre.

The following table gives the results of mechanical analyses of the soil and subsoil of Greenville loam:

Mechanical analyses of Greenville loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18653	Soil	0.5	2.1	2.4	22.7	25.7	38.9	8.2
18654	Subsoil	1.1	2.1	1.3	10.0	13.6	30.4	41.1

BIENVILLE FINE SANDY LOAM.

The soil of the Bienville fine sandy loam consists of about 8 inches of gray to light-brown loamy fine sand. There is usually no distinct line of demarcation either in color or texture between the soil and the subsoil, but the one grades into the other by imperceptible degrees with increasing depth, until at 24 to 36 inches the material consists of a light-brown or reddish-brown, sticky, fine sandy loam. The reddish color of the subsoil is more pronounced on the crests of slight elevations, the color in leveler areas being lighter. Where this soil grades into the flat woods and swamp lands the subsoil is often slightly mottled with drab.

This soil is found in the neighborhood of the larger streams in the southern part of the parish, and is locally known as "hammock" land. Sometimes it is found as small, islandlike elevations at the junction of large streams and is surrounded on all sides by swamp. In such instances it is called "first hammock." Again, it may occur in the second bottoms, or what is locally called "flat woods," and in such cases it is called "second hammock." Slight elevations in the low-lying leveler areas of Norfolk fine sandy loam often have many of the characteristics of "hammock" land, and are often designated by the people as "third hammock." Of these three different kinds of "hammock" land, the first is the one which occurs in the largest areas, is held in highest esteem by the farmers, and is most representative of the type. The subsoil of the "second hammock" land is inclined to be somewhat lighter colored, more "crawfishy," and more seepy than the typical soil. As a whole, it is an easy soil to

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plow and cultivate, and may usually be prepared and planted earlier than the Norfolk fine sandy loam. It was among the first soils to be cleared and put under cultivation.

In surface features it varies from nearly level to rolling, and, owing to this and the porous structure of both soil and subsoil, its drainage is naturally good. It is seldom if ever subject to overflow, but sometimes is cut off from the mainland by inundation of the surrounding swamps.

In the early days these "hammocks" were sought out and cleared because they were considered desirable for home sites and because of their convenience to the extensive ranges for hogs and cattle in the near-by swamps. The soil is naturally a productive one and well adapted to cotton, corn, fruit, and vegetables. It is used exclusively for cotton and corn, and in growing these crops no definite system of rotation is practiced. The average yield for cotton is one-half bale, while that for corn is about 20 bushels per acre. Much larger yields are possible, but the soil has been cultivated continuously for so long that its productiveness is reduced at least one-third. The same rotation is recommended for this soil as for Norfolk fine sandy loam. It is believed that the soil would be an excellent one for peaches, strawberries, and watermelons, besides all kinds of light truck.

The following table gives the results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Bienville fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18663	Soil	0.0	0.3	0.3	17.8	33.1	39.7	9.0
18664	Subsoil	.0	.0	.1	17.1	34.3	27.5	20.4

NORFOLK FINE SANDY LOAM.

The soil of the Norfolk fine sandy loam, to a depth of 10 or 15 inches, is a grayish fine sandy loam, or a loamy fine sand of the same color. In cultivated fields the line of demarcation between soil and subsoil is often distinct, but in forested areas this is not the case. The subsoil is a yellowish fine sandy loam which becomes heavier with depth, and below 24 inches it usually becomes a yellowish sandy clay. At about 30 inches the yellowish color sometimes becomes mottled with drab and gray, and this is especially apt to be true where the drainage conditions are not naturally good.

This type is found in all parts of the parish, but is especially well developed on the lower slopes of the Dugdemona, Saline, and Black Lake bayous. The characteristic surface features are gently rolling

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to nearly level. In the former locations the natural drainage is usually satisfactory, but in the latter artificial drainage, either by means of open ditches or covered drains, is essential to insure the best results. The location of the land is such that artificial drainage is always possible. Owing to these facts and also to its texture, the soil is an easy one to bring into cultivation.

Only a small percentage of the better-lying and better-drained areas are under cultivation, the remainder being still virgin forest or cut-over lands. Formerly the cane, which grew so luxuriantly in the near-by swamps, extended out and covered this soil and furnished an excellent range for cattle. Continuous pasturing has practically removed all of this, and now one of the characteristics of the pine forests upon the Norfolk fine sandy loam is the absence of undergrowth. Shortleaf pine and loblolly pine seem to be the principal growth upon the poorer drained areas, while a few longleaf pines are sometimes seen upon the higher, better drained areas.

The Norfolk fine sandy loam is derived from a veneer of material which reaches part way up the sides of the hills of higher elevation and completely covers many of the hills of lower elevation. It partially fills the large stream valleys and extends under the present alluvial lands of these streams. This deposition probably took place during Port Hudson time.

Thus far only the more rolling and better drained portions of the Norfolk fine sandy loam have been brought under cultivation. On these cotton and corn, and occasionally a small patch of sugar cane, are practically the only crops grown. It is not considered a strong soil by the farmers and there is much complaint that the effects of fertilizers are not lasting. This may be due to the fact that the water table during a large portion of the year stands rather close to the surface, and the greater part or all of the fertilizers which have been applied is carried away by seepage. Upon the higher and better drained areas this trouble is not so serious, but even there the type is not considered a very strong one. The average yield of corn is about 12 bushels, the yields ranging from 8 to 20 bushels per acre. Cotton gives from one-fifth to two-thirds bale per acre, with an average of less than one-half bale.

Judging from the garden vegetables seen growing, and especially the strawberries, it is believed that with available markets or local canning factories the greatest returns would come from growing truck and small fruit crops, instead of cotton and corn. Sugar cane of thrifty growth was seen in small patches in several localities. It is said that the quality of the sirup produced here is excellent and that the average yield is about 250 gallons per acre.

There is a deep phase of the Norfolk fine sandy loam, occurring mainly in the northeastern part of the parish at the headwaters of

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Saline and Black Lake bayous and on the divides between these streams, which is somewhat more productive and better adapted to crops than the other portions of the type. This deep phase, which is shown on the soil map by symbol, has a surface soil with an average depth of 15 to 18 inches, the water table is farther below the surface, and the effects of fertilizers are considerably more lasting than upon the shallower areas.

About two-thirds of the area occupied by this phase of the type has been cleared and cultivated for a long time. Cotton, the main crop, and some corn and sugar cane are practically the only crops grown. It is believed that all kinds of truck crops, small fruits, and vegetables would do well, and that some varieties of peaches and a light wrapper tobacco could also be grown with success. Since the establishment of the fertilizer factory at Arcadia a mixture of equal parts of cotton-seed meal and acid phosphate is used in liberal quantities in the growing of both cotton and corn, and the good result is shown in the increased yields. A system of crop rotation, however, on this phase and on the other cultivated areas of the type should be adopted in which cowpeas play an important part, for continuous cultivation to cotton or some other one crop, without adding organic or vegetable matter, will eventually impoverish the soil and in many cases result in damage by washing and erosion. Deep fall plowing and the growing of winter cover crops are especially recommended for the deep phase of the type.

A large portion of the parish is occupied by the Norfolk fine sandy loam, and although at present extensive areas of the type are covered with timber it will be only a matter of ten or fifteen years before this will have been removed and the land made ready for settlement and farming.

The following table gives the results of mechanical analyses of the soil and subsoil of the Norfolk fine sandy loam and the deep phase of this type.

Mechanical analyses of Norfolk fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18665, 18667	Soil	0.5	0.7	1.1	38.9	22.3	32.4	4.4
18666, 18668	Subsoil	.0	.4	.6	26.9	12.9	29.0	30.3
Deep phase:								
18639	Soil	.0	1.1	6.6	67.6	3.0	17.1	4.7
18640	Subsoil	.0	.5	4.5	46.4	1.4	9.8	37.0

NORFOLK SAND.

The material composing the Norfolk sand is made up of gray and white incoherent sand of prevailing medium texture to a depth of

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36 inches. In the lower depths there is a tendency toward a yellowish color and this is more pronounced in the areas that occur south of Old Sparta. Where the soil occurs on the hills, however, the color is grayish to a depth of 36 inches.

The Norfolk sand occurs principally in the central and southern parts of the parish, and is especially well developed in the vicinity of Old Sparta. Owing to its loose, open texture it is easy to till. In surface features it varies from nearly level to gently rolling in the lowland areas lying adjacent to the bottoms, to hilly and rolling in the upland areas. The drainage is inclined to be excessive in the uplands, and crops are apt to suffer severely from lack of moisture during dry weather. In the lowland, where the water table comes close to the surface, crops are affected little by ordinary periods of drought. The type is derived from the Lafayette formation.

Because of the unfavorable moisture conditions prevailing over much of its area, very little of this type is under cultivation at present, and for the same reason it is not naturally a very productive type. The effects of fertilizers are not lasting and constant heavy applications are required. Cotton and corn are at present the only crops, the yield of the former being about one-third bale and of the latter about 15 bushels per acre. Crops can be planted upon this soil earlier than upon any other type in the area, and now that the early planting of cotton has become so necessary in combating the boll weevil it is suggested that more of this soil could well be used in cotton production. By following a system of crop rotation designed to add organic matter to the soil (and this can best be done by including some of the legumes, preferably cowpeas), much larger yields of both cotton and corn are possible. The soil is very well adapted to the growing of all kinds of early light-truck crops, as well as Irish potatoes, watermelons, and peaches.

The proportion of the parish covered by this type is not great, but under the present conditions with respect to the boll weevil and the increasing demands of the near-by logging camps and sawmills for fruit and vegetables, to which the soil is especially well adapted, it is destined to become an important factor in the agriculture of the central and southern parts of the parish.

SUSQUEHANNA CLAY.

The soil of the Susquehanna clay to a depth of about 3 or 4 inches consists of a brownish-red or red clay loam, the first 2 inches being darker in color, owing to accumulations of organic matter—the decayed remains of leaves and grass. The subsoil is a stiff, tenacious, plastic red clay to a depth varying from about 20 inches to 3 feet, below which the plastic material becomes mottled with drab and

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gray. The proportion of the drab and gray colors increases, until at a depth of 5 or 6 feet the red color disappears and when exposed in road and railway cuts the whole mass is a grayish drab.

Because of the abundance of easily tilled, sandy soils in the parish and the great difficulty of plowing and cultivating the Susquehanna clay, it is held in low esteem for general farming purposes, and practically none of it has ever been cleared and put under cultivation. It occurs in rather large areas south of Gibsland and in the vicinity of Bryceland. It is found in smaller areas in various other parts of the parish.

The topographic features of the Susquehanna clay vary from nearly level to slightly rolling, and in most places artificial drainage would be very helpful if the land were put under cultivation. It is derived principally from the fossiliferous calcareous Lower Claiborne formation which underlies it. There are in some places a good many clayey iron concretions strewn upon the surface, and in other places some broken fragments of fossiliferous clay ironstone were observed.

The type is usually referred to as "hog wallow" or "post oak flats." Scrubby post oak, black-jack oak, some shortleaf pine, and "hog haw" are the characteristic growths upon it. A few farmers have at different times brought small patches of this soil under cultivation where it adjoins or is a part of fields made up of other types of soil, and no one was found who did not believe that the soil is a very productive one if properly handled.

One of the first essentials in putting the Susquehanna clay under cultivation is thorough drainage, both surface and underground. This, together with deep fall plowing and growing cowpeas and other green manuring crops, will loosen and mellow the soil. The soil can be brought to a high state of productivity if plowed deeply for several years and enriched with organic matter; it is very noticeable that the effects of barnyard and stable manure are lasting. Where the drainage conditions are good cotton yields on an average about two-thirds bale per acre. Corn does not do very well, but winter oats seem to thrive. These are always fed in the sheaf, so nothing definite can be said as to the yield of grain. This soil is not well adapted to vegetables or truck crops, but when well sodded with native grasses it produces an excellent pasturage and also fair yields of hay.

Under the present conditions, with an abundance of cheap, easily tilled, productive lands, it is not likely that the Susquehanna clay will be cultivated to any great extent, but if the region eventually becomes thickly settled and land becomes much higher in price it is believed that this soil will be brought under cultivation and its value will be more fully recognized.

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The following table gives the results of mechanical analyses of the soil and subsoil of the Susquehanna clay:

Mechanical analyses of Susquehanna clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18651	Soil	1.6	1.9	1.3	10.0	16.1	28.3	40.4
18652	Subsoil	1.5	2.1	.9	7.6	15.2	17.4	54.8

SUSQUEHANNA FINE SANDY LOAM.

The soil of the Susquehanna fine sandy loam is a gray fine sandy loam, varying in depth from about 6 to 18 inches, with an average depth of about 12 inches. Sometimes there are many iron concretions and fragments of iron crust strewn upon the surface of the hills and ridges. In the virgin state there is a gradual change in texture, with increasing depth; at the surface is found the coarser sand, and the finest materials, like silt and very fine sand, immediately overlie the subsoil. In fields that have been cultivated for several years the soil becomes homogeneous, and the line of demarcation between the soil and subsoil is sharp and distinct. The subsoil consists of a very plastic, tenacious, red or mottled red and gray clay. Very frequently it is a heavy, plastic, tenacious red clay to a depth of 30 inches, below which it becomes mottled with gray or drab, the gray color becoming more pronounced as the depth increases, until, at 4 or 5 feet, the material usually becomes much sandier and lighter colored.

Except where erosion has removed the soil and exposed the subsoil, the type is a fairly easy one to plow and cultivate. Owing to the stiff, clayey nature of the subsoil, the type is not as warm natured as some of the other soils; consequently crops do not start as rapidly as, for example, upon the Orangeburg fine sandy loam. In newly cleared fields the soil is darker colored and more loamy than is usually the case after a year or more of cultivation, unless proper means have been taken to maintain the organic matter content.

The Susquehanna fine sandy loam occurs in large areas in the region south of Gibsland and south of Arcadia and in the vicinity of Bryceland. It occurs on ridges and hills of slightly lower elevation than those upon which the Greenville gravelly sandy loam is found. It is also found in regions where weathering and erosion have been rather active and where the usual surface features are rolling to hilly and often irregular and dissected. This latter condition is especially pronounced at times along the upper reaches of the small streams. The drainage is inclined to be excessive, and, on account of the usual rough topography, great care is necessary in order to

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keep the sand from washing off the cultivated fields and exposing the subsoil. Owing to the plastic, impervious nature of the subsoil and the usual loose, sandy nature of the soil, its natural water-holding capacity is not great, and the soil soon becomes saturated, the water running off over the surface and causing excessive erosion. This in large measure accounts for the rough, irregular surface of the type as a whole.

This soil is derived from the weathering of the fine sands and clays of the Claiborne formation of the Eocene. Owing to the abundance of other available and more desirable land in the parish only a small percentage of this soil has ever been cultivated. It is still largely covered with its original forest growth of post oak, black-jack oak, shortleaf pine, and dogwood, and it is characterized by numerous thickets of post oak and black-jack oak, which are sometimes almost impenetrable, even to a man on foot. When well situated and carefully cultivated this is a safe soil for all of the general farm crops of the region, and eventually, when land becomes scarcer and more valuable, larger areas of this type will be brought under cultivation.

Cotton and corn are the principal crops. This soil is usually considered a little better adapted to these than is the Norfolk fine sandy loam, for the reason that it can be built up into a stronger soil and the effects of fertilization are much more lasting. When the land is "fresh," that is, just cleared, and contains an abundance of humus and organic matter, it produces from two-thirds to three-fourths bale of cotton and from 25 to 35 bushels of corn per acre, but after three or four years of continuous cropping the yields usually fall to about one-third bale of cotton and 12 bushels of corn per acre. This soil is also well adapted to truck crops, and it is believed that peaches could be successfully grown on ridges or hills where the sand has a depth of over 15 inches.

Shallow plowing and ridge cultivation are practiced on this soil, as upon all other soils of the parish. Deeper plowing is particularly to be desired, and especially so where the subsoil comes within 7 inches of the surface. The soil is said to be very susceptible to drought, and in overcoming this deep plowing is very essential, for by loosening up the subsoil its water-holding capacity will be greatly increased. In the same way the tendency to erode may be reduced. The growing of deep, fleshy-rooted legumes, like cowpeas, will also aid very materially in opening up the subsoil and increasing its power to absorb rain water.

The oat crop does exceptionally well upon this soil, and since it protects the land from the serious effects of washing and erosion it is strongly advised as a winter cover crop. The following rotation is also suggested as being well suited to the soil and conditions found on this type in Bienville Parish: Cotton one year, followed by corn

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the next year. At the last cultivation of the corn cowpeas should be sown broadcast between the rows. After the corn is harvested the ground should be deeply plowed and sown to winter oats, which will furnish an excellent pasture during January, February, and March. Oats are not usually injured by pasturing and they should be allowed to mature, then thrashed or fed in the sheaf. Cowpeas should be sown after the oats are harvested. The ground should always be plowed deeply, and this practice, together with the above rotation, will not only maintain the original productiveness of the soil, but will increase it from year to year. About 17.1 per cent of the area is occupied by this soil, so that it has considerable influence upon the agricultural conditions and value of land in the parish. A large percentage of the soil is held by lumber companies. With the timber it brings from $15 to $25 an acre. Cleared land for farming purposes ranges from $5 to $12 an acre.

The following table gives the average results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Susquehanna fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18655, 18657	Soil	0.6	0.7	8.6	53.7	13.9	17.4	5.6
18656, 18658	Subsoil	.2	.4	3.6	20.2	15.8	19.4	40.1

ORANGEBURG FINE SANDY LOAM.

The Orangeburg fine sandy loam consists of 6 to 18 inches of gray or grownish-gray, fine to medium textured sandy loam, underlain by material which ranges from a red clayey fine sandy loam to a red fine sandy clay extending to a depth of 36 inches or more. Usually the line of demarcation between the soil and subsoil is quite distinct both in color and texture. In the forested areas, however, this is not always the case. The surface is occasionally strewn with a scattering of quartz gravel.

Occurring in rather small, disconnected areas, the Orangeburg fine sandy loam is found in all parts of the parish, and especially in the southern half. It is found upon hills and ridges, and has excellent natural drainage. Owing to this, to its loamy texture, and to the usual absence of rough surface features, it is very readily brought under cultivation, and it was one of the first soils to be farmed by the early settlers.

The Orangeburg fine sandy loam is derived from the unconsolidated sandy and sandy clay formations which underlie it. These are probably Lafayette in age. Originally the land of this type of

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soil was covered with forests of longleaf and shortleaf pine, with some scattering red oak and hickory. Cotton and corn are the crops, and it is considered a good, safe soil for these in almost any season. The yield of cotton ranges from two-fifths to three-fourths bale per acre, with an average of about one-half bale. Corn ranges from 10 to 25 bushels per acre, with an average of about 20 bushels. It is considered a better soil for corn than for cotton. The above yields are those for crops without an application of commercial fertilizer. By using 200 or 300 pounds of fertilizer per acre some farmers maintain an average yield of about two-thirds bale of cotton and about 25 bushels of corn per acre. Judging from vegetables seen growing in gardens and the success of a few farmers near the towns who have been growing truck on a small scale, the Orangeburg fine sandy loam is one of the best soils in the area for all kinds of small fruit and vegetables, and with the increasing demand for these products it is believed that it would be much more profitable to use the land for these crops than for cotton. In the early days the farmers grew some tobacco for home use upon this soil, and the success had in growing Cuban filler tobacco upon this same type of soil in Texas suggests that this crop might profitably be introduced here. In favorable years Elberta peaches grow to perfection upon this soil, and this is another industry whose development is feasible.

The cultural methods on the Orangeburg fine sandy loam are practically the same as on the other types of the parish. The advantages of deep plowing, of the rotation of crops, and of growing cowpeas or other legumes have been little appreciated. These matters should be given more consideration by the farmers.

Although the Orangeburg fine sandy loam occurs in rather small, isolated patches, these are so numerous and held in such high favor as to make it an important soil locally.

The following table gives the average results of mechanical analyses of the soil and subsoil of the Orangeburg fine sandy loam:

Mechanical analyses of Orangeburg fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18645, 18647	Soil	0.1	0.6	1.9	51.7	16.5	25.0	4.1
18646, 18648	Subsoil	.0	.1	1.5	32.5	11.6	23.5	30.3

ORANGEBURG SANDY LOAM.

The soil of the Orangeburg sandy loam consists of a gray or brown, medium to fine textured sandy loam, with a depth of about 15 inches. Below this and reaching to a depth of more than 36 inches occurs a

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subsoil of brownish-red to yellowish-red, medium to fine textured sandy loam. This material contains much less organic matter and is less coherent than the soil, but judging from a field examination, and also from the mechanical analyses, the size of the soil particles is very nearly the same for both soil and subsoil. Occasionally little lenses of clay 2 or 3 inches in diameter and a half inch or more thick are found in the subsoil. A little gravel is sometimes found strewn upon the surface.

This soil occurs in patches in various parts of the parish, but is especially well developed about 2 miles west of Gibsland and farther south in the central part of the parish. It is an exceedingly easy soil to cultivate, and is highly prized. Wherever found the fields are usually entirely free of stumps and deadened timber, indicating that the land has been under cultivation a long time. The original forest growth is said to have consisted mainly of longleaf pine.

The topography is rolling to slightly hilly and the natural drainage is excellent. In fact, if anything, drainage is too rapid, and great care has to be taken to prevent the hills from washing and eroding, notwithstanding the fact that the subsoil is open and porous. Moles burrow to a considerable extent in this soil and often after a heavy rain gullies are noticeable on the hillsides which before were merely underground mole trails. One very noticeable characteristic of this soil is that the road cuts are deep and often trenchlike where they pass over hills.

The Orangeburg sandy loam is usually associated with areas of Norfolk sand. The latter type appears to have been an ancient beach laid down probably at the close of the Tertiary period, and it is believed that the Orangeburg sandy loam represents a close shore deposit of the same period. The ease with which this soil is handled makes it very popular when well located. The best crop yields are usually obtained during a year of abundant rainfall, as crops are inclined to suffer in times of drought. All of the general farm crops of the region are grown on it, but cotton and corn are the most popular. Cotton yields from one-fourth to one-half bale per acre; a fair average is about one-third bale per acre. Corn yields vary from 8 to 20 bushels, averaging about 15 bushels per acre. A few thrifty-looking peach trees were observed, and it is believed that this soil is well adapted to some such peach as the Elberta. A few cantaloupes and watermelons are grown for home use, and judging from the stated yields there are excellent possibilities in this direction. The success of garden patches of strawberries, radishes, onions, sweet and Irish potatoes, and small berries indicates that all of these crops can be profitably grown provided a market can be had for them. It would seem that as a whole the soil is better adapted to truck farming than to the growing of cotton and corn, and with the

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establishment of canning factories in this section the trucking industry would receive its share of attention. Since the advent of the boll weevil this soil is in greater demand for cotton because of the desirability of early planting, thus getting the plant well started before the pest appears in destructive numbers in July and August.

This soil needs yearly attention in order to maintain its productiveness. The effects of fertilizers are not as lasting as upon soils having a heavier subsoil. The best results seem to be secured with well-rotted barnyard manure. The turning under of cowpea vines seems also to be very beneficial. A few farmers have been applying equal parts of cotton-seed meal and acid phosphate with apparently increased yields.

It is recommended that instead of growing cotton and corn year after year the following rotation be used: Cotton one year, followed by corn the next, sowing cowpeas with the corn at last cultivation. After the corn is harvested sow some good winter cover crop to protect the ground from washing and gullying during the winter months and at the same time to furnish winter pasturage. Hairy vetch, which is a legume and a soil renovator of great value, is a very satisfactory winter cover crop for such light sandy types as the Orangeburg sandy loam. The land, however, must be well prepared and well manured to obtain the best results. If hairy vetch is not used, winter oats will be found to do fairly well and furnish some winter pasturage. After the winter cover crop is harvested the ground should again be sowed to peas.

This soil is not of great extent, only 4.8 per cent of the parish being occupied by it, but it was one of the first soils to be reclaimed from the forests and has considerable influence upon the agricultural conditions and value of lands in the parish. It ranges in price from $5 to $15 an acre, depending upon location and improvements and the amount of land under cultivation.

The following table gives the results of mechanical analyses of a sample of the soil and subsoil of this type:

Mechanical analyses of Orangeburg sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18643	Soil	0.3	2.2	41.1	29.0	5.8	17.9	3.6
18644	Subsoil	.0	2.0	36.1	27.8	4.3	20.1	8.9

ORANGEBURG FINE SAND.

The Orangeburg fine sand consists of 10 to 12 inches of light-brown or gray, medium to fine-textured sand, underlain by material

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of the same texture, but of reddish color, extending to a depth of 36 inches or more. At about 24 inches the subsoil sometimes becomes slightly sticky. This is an easy soil to till, breaking into a pulverulent seed bed without tendency to pack or bake.

Small areas of Orangeburg fine sand are scattered here and there over the western third and southern half of the parish. It occurs upon the divides and narrow ridges of high elevation, and has a rolling to hilly surface. This, together with the loose, open nature of the soil and subsoil, insures rapid drainage, which is apt to be excessive. As a result, land of this type is usually considered of low value in the production of cotton and corn. Over limited areas the surface features resemble sand dunes, and taken as a whole the soil appears to be the remnant of an ancient beach line. The material from which the type is derived belongs to the Lafayette mantle.

In some of the more level locations, where moisture conditions are naturally the most favorable, small areas are sometimes successfully used for general farming. In such locations light truck crops and watermelons seem to do exceptionally well, but in order to keep the soil in a productive state frequent applications of manure and fertilizers are necessary. No peaches were seen growing on the soil, and if experimented with it is recommended that only the best and most productive portions of the type be tried.

Having a limited area, the Orangeburg fine sand has little or no material influence upon the agricultural conditions and land values in the parish. Most of the type is still forested with longleaf pine and chinquapin. The abundance of the latter and the presence of a weed known locally as "bull nettle" have given rise to the descriptive terms "chinquapin" or "bull-nettle" land.

The greatest value of the type lies in its pine timber. Where this has been removed the land can be purchased for about $5 an acre.

The following table gives the results of mechanical analyses of the soil and subsoil of the Orangeburg fine sand:

Mechanical analyses of Orangeburg fine sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18641	Soil	0.0	0.8	11.1	71.6	2.7	8.5	5.6
18642	Subsoil	.0	.8	10.3	71.2	2.7	8.5	6.5

MEADOW.

The Meadow comprises that portion of the stream valleys subject, especially during the winter and spring months, to such frequent overflow as to render the land unfit for farming. The material com-

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posing these bottoms is quite variable in short distances, but sand seems to be the predominating material.

Meadow occurs in all parts of the parish, but the largest bodies are found along the larger streams like Black Lake, Dugdemona, and Saline bayous. On the lower courses of these streams the overflow land is sometimes a mile or more in width, and formerly supported dense canebrakes, which furnished excellent winter pasturage. Although the bottoms are wide, the stream channel itself is usually only a few rods in width, and meanders from one side of the swamp to the other, forming innumerable loops, bends, and oxbows. These oxbows sometimes become detached during floods and remain as small ponds or lakes, and occasionally a number of these are found parallel to the main stream.

At present these bottoms have no value from an agricultural standpoint, but it is believed that by diking there are many locations where rice might be profitably grown. To some extent these swamps afford good grazing for cattle and hogs. Formerly there was a great abundance of oaks, which furnished an almost inexhaustible supply of mast for hogs during the winter months. Many of the oak trees have been cut for staves and lumber, so that the quantity of mast is greatly reduced, and the canebrakes have been pastured so long that they are not so good as formerly. Besides several varieties of oak, the native forest consisted of cypress, hickory, beech, white gum, and loblolly pine.

SUMMARY.

Bienville Parish lies near the center of northwest Louisiana. The northern part of the parish is within the shortleaf pine hill belt, while the southern part is within the longleaf pine hill belt.

The earliest permanent settlement in the parish was made in 1826, and most of the important permanent settlements occurred between that date and 1850. The region was settled by emigrants from Kentucky, Tennessee, Alabama, Georgia, and Mississippi. These people and their descendants have been exclusively a farming people, and until the advent of railways stock raising constituted a very large part of their income. In the northern part of the parish, however, cotton was grown to a large extent before the railways entered the parish.

During the last twenty-five years there has been marked progress in all lines, owing largely to the great activity in lumbering and railway construction. More money is in circulation, higher wages are being paid, the population is increasing, a better system of public schools prevails, and the agricultural practices are improving to meet the increasing demands for farm products.

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The climate of the parish, besides being well suited to the production of the staple crops of the South—cotton and corn—is also admirably adapted to small fruits and vegetables for canning purposes and to truck crops in general.

The rapid removal of the timber is throwing considerable areas open to settlement, and the people in less favored localities in the surrounding parishes are taking advantage of this opportunity to buy excellent lands at reasonable prices.

The chief towns and trading centers of the parish are Arcadia, Gibsland, and Bienville. The parish as a whole now possesses excellent transportation facilities, and it is believed that when the production of fruit and vegetables exceeds the local demands no difficulty will be experienced in obtaining rates that will enable profitable shipment to outside markets.

Eleven types of soil were recognized and mapped in the parish. The larger part of the parish is covered by fine sandy loams. The Norfolk, the Orangeburg, the Susquehanna, and the Greenville are the most important series. It is believed that on the Greenville gravelly sandy loam Elberta peaches and a fine quality of cigar wrapper tobacco can be profitably grown.

A systematic rotation of crops should be followed on all the soils of the parish. On the upland sandy soils a three-year rotation of cotton, corn, and oats, with cowpeas sown both at the last cultivation of the corn and after harvesting the oats, is suggested. All of the soils need deeper plowing and a more thorough preparation of the seed bed. The heavier clayey types should be tile drained and a four or five year rotation would be best upon them. Cowpeas should figure in all rotations. The growing of winter cover crops and more forage crops, level cultivation on level well-drained lands, and the use of better farm machinery are strongly recommended.

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SOIL SURVEY OF EAST CARROLL AND WEST CARROLL PARISHES, LOUISIANA.

By E. L. WORTHEN and H. L. BELDEN.

DESCRIPTION OF THE AREA.

East Carroll and West Carroll parishes are located in the extreme northeastern part of Louisiana. The Mississippi River forms the east boundary of the area and the Boeuf River the greater part of the western boundary, while the parishes themselves are separated by Bayou Macon. The area is bounded on the north by Arkansas, on the east by Mississippi, on the south by Madison and Richland

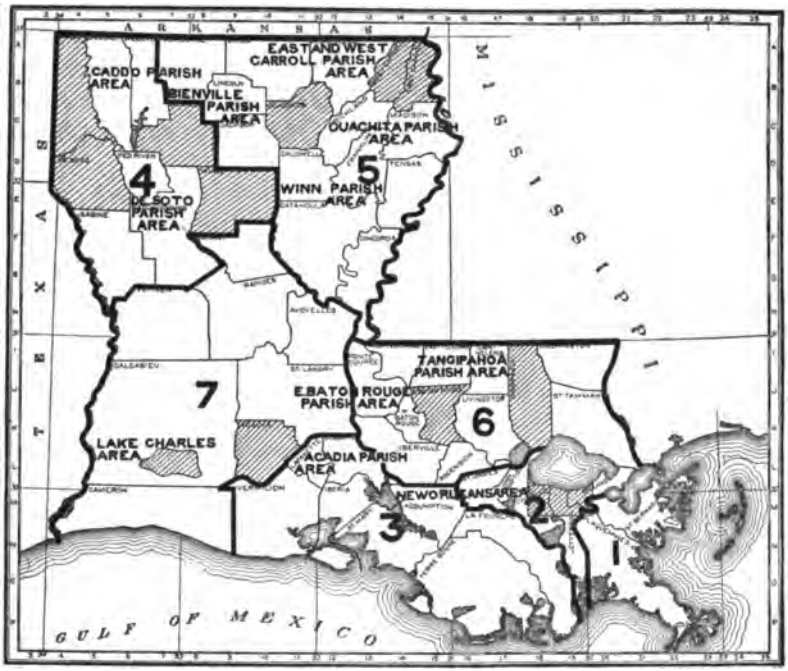

FIG. 22.—Sketch map showing location of the East Carroll and West Carroll parishes, Louisiana.

parishes, and on the west by Richland and Morehouse parishes. It comprises a total area of 465,280 acres or 727 square miles.

The surface of the area presents a very level topography. The greatest elevation occurs just west of the Bayou Macon and constitutes an upland ridge running north and south the entire length of West Carroll Parish and having a width of 4 to 6 miles. The highest part of this ridge is adjacent to Bayou Macon and it slopes to the west, grading almost imperceptibly into the overflow land along Colewa Bayou and the Boeuf River.

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The highest parts of East Carroll Parish are along the Mississippi River and some of the larger bayous, where continuous overflows have deposited such large amounts of sediment that distinct ridges have been built adjacent to the streams. Back from the river front or "front land" the surface dips down, forming a basin-shaped area between this higher land and the ridge in West Carroll Parish. Tensas, Macon, and Joes bayous all drain south through this depression, and together form the principal drainage outlets of East Carroll Parish. On account of numerous overflows in the past, a rather distinct ridge has been formed for some distance along each of these bayous. The one along Joes Bayou is especially prominent. West Carroll Parish drains largely west into the Colewa Bayou and the Boeuf River.

Fully two-thirds of the area is not sufficiently drained at present to allow agricultural occupation. The surface is so flat that the streams are sluggish, and the small ones particularly have not had sufficient fall to cut definite channels. The streams of West Carroll Parish consist largely of wide, shallow slashes which are wet and swampy much of the year.

Originally all of the area except the ridge just west of Bayou Macon was subject to frequent inundation by the floodwater of the Mississippi River. There is now an exceptionally strong levee along the Mississippi which has been constructed under National and State supervision. It is being strengthened continually, and it is hoped that this levee will soon be made strong enough to prevent any overflow whatever. The breaking of this levee has caused some very disastrous floods within the last twenty years. At such times the lower areas of both parishes were covered with from 4 to 12 feet of water.

Lake Providence, situated in East Carroll Parish, is the name of the principal town and also of the lake upon which it is situated. The lake represents an old river channel which has been left as an oxbow lake in the natural straightening of the river. It is about 7 miles long and a little over half a mile wide, but receives little drainage, as its banks have been built up higher than most of the surrounding country. The area as a whole drains south and west into the Red River and thence into the Mississippi.

The negroes greatly outnumber the white population in East Carroll Parish, but in West Carroll there are more whites. The census of 1900 gave the population of the parishes as follows: East Carroll, 11,373; West Carroll, 3,685.

The white population is largely of American birth, being descendants of the older settlers of Louisiana or those from the adjoining States to the east and north. Within recent years considerable northern capital has been invested in the area, but few people from the North have made their homes here. Most of the white people

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of East Carroll Parish live in the town of Lake Providence. In West Carroll Parish, on the other hand, the white people are distributed throughout the better drained areas.

The greater part of each parish, or nearly three-fourths of the whole area, is still a dense hardwood forest.

Lake Providence, situated, as before stated, on the lake of the same name and the Mississippi River, is the only town of importance in the area, and is the parish seat of East Carroll Parish. It has a population of 2,000, about two-fifths of which are white. The town is progressive and has electric lights, waterworks, excellent schools and churches, and many handsome residences. Floyd, the parish seat of West Carroll Parish, is situated on Bayou Macon, in the southeastern part of the parish. The development of the town has been retarded by the position of the railroads, which were built on each side instead of running into the town. It has a population of perhaps 100. Oak Grove and Pioneer are small railroad towns in West Carroll Parish and have been built up largely within the last year, since the completion of the railroad.

The St. Louis, Iron Mountain and Southern Railway, completed in 1904, passes through East Carroll Parish from north to south. A branch of the same road extends from Eudora, Ark., nearly to the south line of West Carroll Parish. It is expected that on its completion this branch will form part of the main line from St. Louis to New Orleans. Practically all of the freight of East Carroll Parish, with the exception of lumber, is still shipped by water.

The highways through the area are very poorly cared for. Many of them are practically impassable much of the time, and it will require a large expenditure to construct good roads through the low sections.

New Orleans, Memphis, and Vicksburg, in the order named, are the leading cotton markets for the area. The rice is marketed almost wholly in New Orleans.

At the present time the two parishes are comparatively undeveloped but possess remarkably rich soils, which, with proper drainage and absolute protection from overflow, should produce agricultural products valued at many times the present output.

CLIMATE.

The climate is that of the warm temperate region of the United States and is favorable to a much more diversified farming than is at present practiced. The winters are short and mild; the summers long and hot. There are five months—May, June, July, August, and September—of summer weather, although numerous warm days also occur in March, April, October, and November. During the winter months there are occasional rather severe frosts, but freezing weather seldom lasts for over a few days at a time. The ground never freezes

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more than a few inches and soon thaws. There are usually many warm, pleasant days throughout the winter, and often the change to freezing weather is so sudden that the cold seems very severe. The rather high humidity exaggerates the degree of cold. The temperature seldom falls more than 10° below the freezing point, and 20° below freezing is very exceptional, occurring only during the most severe winters. It seldom rises above 100° F. during the summer, but on account of the high humidity and the frequent long periods during July and August, when the temperature ranges from 90° to 100° F., the heat becomes oppressive.

The heaviest rains occur during the winter and spring months, and crops when properly cultivated seldom suffer from lack of moisture. The fall and early winter is the driest time of the year, and therefore favorable for the picking of the cotton crop. Killing frosts seldom occur before the first of November nor later than the last of March.

The following table, compiled from the records of the Weather Bureau station at Lake Providence, gives the normal monthly and annual temperature and precipitation, the absolute maximum and minimum monthly temperatures, and the average depth of snow:

Normal monthly, seasonal, and annual temperature and precipitation.

Month.	Temperature.			Precipitation.	
	Mean.	Absolute— Maximum.	Absolute— Minimum.	Mean.	Snow, average depth.
	°F.	°F.	°F.	Inches.	Inches.
December	49	85	9	3.8	0.8
January	48	84	10	4.9	.2
February	48	85	−4	4.9	1.7
Winter	48	.....	.....	13.6	2.7
March	58	90	22	6.4	.3
April	68	92	36	3.6	.0
May	73	98	40	3.9	.0
Spring	66	.....	.....	13.9	.3
June	78	99	50	6.1	.0
July	82	104	61	4.5	.0
August	82	106	58	4.8	.0
Summer	81	.....	.....	15.4	.0
September	76	100	45	2.9	.0
October	66	95	31	2.1	.0
November	57	89	18	3.0	.0
Fall	66	.....	.....	8.0	.0
Year	65	106	−4	50.9	3.0

Date of latest killing frost in spring, March 30; earliest in fall, October 15. Average date of last in spring, March 14; first in fall, November 8.

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AGRICULTURE.

There was little agricultural development in the area prior to 1820, although the Indians and a few Spanish settlers had cleared and put under cultivation a few acres. The first permanent settlers arrived in the area in the early twenties, coming largely from States farther east, as well as from Kentucky and Tennessee, and made their homes along the west bank of Bayou Macon and at various points along the Mississippi River and the bayous of East Carroll Parish. It was not until about 1840 that settlers began to arrive in any great numbers. This date marks the beginning of a long period of agricultural prosperity.

These early settlers brought their slaves with them, and large, prosperous plantations soon developed, especially in the eastern section of the area. What is now West Carroll Parish was divided into smaller tracts, which were operated on a much less extensive plan, though there was an occasional large plantation even in this section.

Cotton was the important product at this time. Enough corn was produced, however, to supply the needs of the people and their live stock. This period of prosperity lasted for about twenty years and reached its height just before the outbreak of the civil war.

Since 1865 agricultural development has been very slow. It has been retarded by occasional almost complete crop failures, due to overflows, by trouble in securing satisfactory labor and the inability to secure settlers, by the one-crop system of farming, and by the lack of proper drainage. The natural fertility of the soils certainly justifies a much more rapid development than has taken place during the last forty years.

Cotton has continued to be the leading crop, and is to-day about the only agricultural product not wholly consumed within the area. Even now the annual output of cotton is hardly half what it was for a long period before the war. Corn is the second crop in importance. It is the aim of the planter to produce enough to feed the plantation stock, but this is seldom accomplished and it is necessary to obtain considerable quantities of corn and oats from the corn belt. Rice growing was introduced in 1905 and since then the acreage planted to this crop has steadily increased. Oats, hay, potatoes, fruit, and live stock are other agricultural products of importance. The census of 1900 credits the area with a total production of 24,613 bales of cotton and 369,280 bushels of corn. Of this amount East Carroll Parish produced about 80 per cent of the cotton and 65 per cent of the corn.

Cotton is generally planted between the first and the middle of April. Some farmers plant as early as March 15 and others as late as the middle of May. The cotton is thinned when small and then

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as a rule hoed twice. Most of the planters cultivate with a sweep plow once and then give the crop two or three subsequent plowings. Generally speaking, the methods employed in the culture of cotton are the same throughout the area, both on upland and bottom land. The yields vary from one-half bale to over a bale to the acre. Most of the cotton is the short-staple variety, though considerable long-staple is grown in East Carroll Parish.

Early corn is planted in March and late corn in May. It is always planted in ridges. The crop is often neglected and receives only one or two plowings. Cotton, being the favorite crop, is always given first attention. Corn yields from 15 to 40 bushels to the acre.

Rice has been grown to a limited extent for the last few years and gives promise of becoming an important crop on the alluvial lands adjacent to water. The present rice plantations are located along Lake Providence and the Mississippi River, which furnish abundant water for irrigation. These fields are laid off into squares by small levees or dikes, and are so arranged that water can be supplied from adjacent canals whenever needed. They are kept covered with water during the entire growing season. This water is pumped from the river or lake by large steam pumps. The rice is harvested with modern self-binders and thrashed with the ordinary thrashing machine. The yield varies from 15 to as high as 40 sacks per acre.

The raising of live stock is developing into an industry of some importance in the area. Cattle, hogs, sheep, and poultry are raised on a small scale. As yet, however, much meat is imported into the area and practically all of the work stock is obtained from outside. The live stock in East Carroll Parish is somewhat superior to that in West Carroll.

Very little fruit of any kind is produced in the area. Figs are grown in a small way for home use, and peaches, plums, and apples yield well on the upland in West Carroll. Vegetables and berries are grown on the lighter soils. Pecans grow wild on the better drained soils of East Carroll Parish and the production of improved varieties on a commercial scale would bring substantial returns.

Some sugar cane is grown and many of the soils are adapted to it, but the area is situated too far north for the profitable production of this crop.

Very little attention is paid to the rotation of crops. Cotton is commonly grown on the same land year after year, though it is occasionally rotated with corn. Rice is not well adapted for rotation and will probably be produced on the same land as long as profitable returns are secured.

The adaptation of crops to soils is not given much thought. This is not surprising, since the cultivated soils are about equally

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suited to cotton and corn. Corn is more commonly planted on the heavier types in the bottom land, and the lighter phase of the Yazoo fine sandy loam is nearly always used exclusively for cotton.

Practically no fertilizers are used in the area. It is recognized that the growing of cowpeas improves any of the lighter soils, and that barnyard manure is very beneficial to the soil of the upland ridge in West Carroll Parish.

There are three distinct classes of farmers in the area—the large planter, the small renter, and the farmer who owns and operates his own place. The large plantations often include 500 acres or more of cultivated land. They are commonly rented in small tracts of 10 to 30 acres each to negro tenants, either for cash, for a definite amount of cotton per acre, or for a percentage of the crop produced. Often parts of these plantations are worked with hired labor and are always managed by the owner or a salaried overseer. The improvements on these large plantations commonly consist of the owner's or manager's residence, a plantation store, a modern cotton gin, and numerous one to three room negro cabins. The tenant rents his mules from the owner and purchases his goods at the plantation store on credit.

This method of farming is commonly practiced in East Carroll Parish. In West Carroll Parish, on the other hand, the farms are of smaller size; many of them are worked without negro labor, while others are rented to negroes. In this parish there are some white renters, but the negroes form the greater proportion of the tenants of the area.

Land rents for $4 to $7 an acre. Under the share system of tenancy the owner receives one-half of the crop when he furnishes the work stock, implements, and seed, and one-third when the tenant has his own equipment. A dwelling is always furnished free to the tenant. The negro is almost solely depended upon to supply the farm labor. The better class have been able to get ahead, have bank accounts, and occasionally own farm property.

Labor by the day receives from 80 cents to $1, and by the month from $15 to $18. Women are paid from 50 to 75 cents a day for field labor. Fifty and 60 cents per 100 pounds are the customary prices paid for picking cotton, though late in the season 75 cents and $1 per 100 is given in order to hasten the harvest.

The farm lands vary somewhat in price. The improved areas of East Carroll Parish are held at $25 to $40 an acre, while the cleared uplands of West Carroll can be bought for $12 to $25. The timbered sections throughout the area are valued at about $10 an acre, irrespective of the soil, but the price varies somewhat with the quality of the timber.

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A more diversified farming should be practiced. Cotton and corn, instead of being grown on the same land year after year, should be supplemented with a systematic rotation in which some leguminous crop enters every few years. The credit system prevents the adoption of a more systematic crop rotation, because the planter or the merchant considers the cotton the only cash crop and the only one he can safely loan upon.

SOILS.

The area has two distinct physiographic soil divisions, both of which are of comparatively recent geological origin. They are the loess-covered upland of West Carroll and the broad, level country covered with Mississippi alluvium which forms all of East Carroll Parish and much of the lower parts of West Carroll.

Of these two formations the loess is the older. It forms a continuous covering over the upland of the area, and varies in thickness from 5 to 25 feet or more. The average thickness is probably between 10 and 15 feet. The origin of this material is probably not definitely determined, but at present it is conceded by most geologists that the loess along the Mississippi River has been formed by the combined action of wind and water. In this area it would appear that the latter agent has been largely responsible for the deposit.

This loess presents a remarkably uniform texture throughout its whole extent in the area. It consists of a loose, unconsolidated coarse silt loam to very fine sandy loam with a somewhat heavier subsoil. It has given rise to two important soil types—the Richland silt loam and the Carroll silt loam.

This upland seldom rises over 30 or 40 feet above the surrounding bottoms. It is of a level to gently rolling topography, being higher along the east side and sloping gently to the west. This ridge has not been gullied, as is the case with much of the loess of the Southern States.

The loess is underlain in most cases by a thin layer of reddish-brown sand of the Pleistocene age, which in turn rests upon a stratum of heavy, bluish, mottled clay. In some cases the sand layer is absent and the loess is found resting immediately upon the clay. This clay substratum, which is exposed in only a few places along the east edge of the ridge, is probably Eocene. These lower formations have very little influence on the soils, since the loess uniformly covers them to a depth of 10 feet or more.

The range of elevation within the flood plains is not over 20 feet. The soils are of very simple geological origin. They have been formed by the continuous deposition of sands, silts, and clays by the overburdened waters of the Mississippi River and minor streams during successive periods of inundation. This area is still in the

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formative stage, as each succeeding inundation even now deposits new material which frequently alters the surface of certain small areas of the soil. Because of the origin of the soil of this section it is all locally spoken of as "made land."

This alluvium has given rise to five important soil types—the Yazoo fine sandy loam, the Yazoo loam, the Wabash and Sharkey clays, and the Waverly silt loam, as well as a few others of local extent.

The following table gives the name and area of each of the types of soil found in the parishes:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Sharkey clay	112,832	24.2	Yazoo fine sandy loam	24,576	5.3
Richland silt loam	87,104	18.7	Yazoo fine sand	768	.2
Wabash clay	85,120	18.3	Boeuf fine sandy loam	320	.1
Carroll silt loam	83,584	18.0	Yazoo coarse sand	256	.1
Waverly silt loam	41,536	8.9			
Yazoo loam	29,184	6.2	Total	465,280	.....

YAZOO FINE SAND.

The Yazoo fine sand, to a depth of 36 inches, consists of a gray, incoherent sand of fine texture. Occasionally the surface few inches contains a small quantity of organic matter, but in most cases it is of the same structure throughout the profile. This sand consists largely of quartz, though close inspection always reveals a small percentage of feldspar and mica grains. It is of very limited extent, there being only a few small patches, with a combined area of less than 2 square miles, situated about 5 miles south of Lake Providence. It has been formed at recent breaks in the levee, where the swift inrushing current has deposited this sandy material inside the levee. The type is of little agricultural value, the greater part being covered with a dense growth of young willows.

The results of a mechanical analysis of this type of soil are given in the following table:

Mechanical analysis of Yazoo fine sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18638	Soil	0.0	0.3	5.5	90.7	1.9	1.0	1.0

YAZOO COARSE SAND.

The Yazoo coarse sand comprises a few local deposits of 10 to 100 acres each of coarse sandy material east of Lake Providence. In

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most cases it consists of a coarse sand to fine gravel 36 inches deep. The surface few inches is occasionally colored brown by small amounts of humus, and frequently considerable clay is found mixed throughout the type. It was deposited in a very swift current at the time the river occupied the old bed and has never received a subsequent covering of finer material. The extent of this soil is so limited and its character so variable that it hardly deserves to be considered a soil type. It is of practically no agricultural value.

YAZOO FINE SANDY LOAM.

The soil of the Yazoo fine sandy loam consists of a light-brown very fine sandy loam with an average depth of about 9 inches. It is of a loose, friable structure, absorbs water readily, and dries rapidly after rains, thus making it a very desirable soil to cultivate. The subsoil is a yellow, gray, or mottled-yellow fine to very fine sandy loam and very frequently becomes distinctly heavier at about 30 inches. In fact, the heavier subsoil occasionally consists of a clay loam or clay adjacent to the heavier soil types.

The type is found occupying the higher parts of the land fronting on the Mississippi River and narrow bands or ridges adjacent to many of the bayous. This soil is rather variable, due largely to the rapidity of the flow of water during its formation and somewhat to the age of the deposit. Along the bayous and in the vicinity of Lake Providence the soil varies, being uniformly deeper and of a lighter texture along the lake and bayou banks and becoming gradually heavier as the loam or clay types are approached. Along sharp bends of the bayous, and especially along the river in the extreme northern part of the parish, the surface assumes a ridgy character and the texture of the soil is very variable, the tops of those small ridges being a loamy sand and the depressions between a heavy loam or possibly a clay loam. Along the bayous this condition is due to the flood waters cutting across the bends, while the surface in the northeast corner of the area owes its character to frequent annual inundations. An old break in the levee was left unattended for a considerable period and at each high stage of the river the water would flood the lower area along the Bayou Macon.

Near the bayous and in the vicinity of the lake the soil seems to be of older formation and has more organic matter mixed with the surface soil than along the river front in the north and south parts of the parish.

The type occupies the higher parts of the Mississippi flood plain. It is of a very level character, with a gentle slope away from the streams. It is the best drained of the alluvial soils and is least liable to inundation. Where the type occurs along the river front the

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seepage water often becomes injurious for a quarter of a mile or more back from the levee at times of high water.

The type is wholly of alluvial origin. It represents the coarser deposits of the bottom lands and consequently the first one laid down when the current in any way became checked. Thus when the river or swifter flowing bayous became swollen and began to overflow their banks the carrying power of this overflow water was suddenly lessened and the coarser material deposited near the streams, while the finer particles were carried farther inland and deposited only as the current became very sluggish. These inundations, occurring continually as they did year after year, built up distinct ridges of this fine sandy loam along many of the bayous and the river front.

This was the first of the alluvial soils to be put under cultivation. The early settlers chose it because of its light texture, its elevation affording better drainage and better protection from overflow, and because of its proximity to the streams. Some areas of the type have been under cultivation for at least eighty if not one hundred years. The type was much more extensively cultivated before the war and has partly gone out of cultivation.

The Yazoo fine sandy loam is a very productive soil and adapted to a diversity of crops. Cotton, corn, vegetables, and small fruits are all suited to this soil. It is very probable that the lighter phases, especially where they have been farmed to corn and cotton for a number of years, would be benefited by fertilization. Cowpeas and soy beans would both grow well, and by turning under a heavy growth of these legumes every few years the productivity of the type would be greatly increased. There is a tendency for the surface soil to be slightly deficient in humus and any method of farming that would economically increase the content of this material would be advisable.

Cotton and corn are the only crops of importance being produced on this soil. The former yields as high as a bale to the acre during favorable seasons when well cultivated. Corn produces from 15 to 30 bushels per acre. The rice fields are generally made up partly of this type, but for this crop the loam or clay soils are superior. The fine sandy loam is often of such an open structure that it allows too easy percolation, and consequently there is loss of irrigation water in the cultivation of this crop. Small home gardens are found in which some peaches, pears, and figs are produced, but commercial fruit growing should never be attempted on this type. Extensive market gardening, however, should prove profitable, provided suitable markets were obtained. Pecans are peculiarly adapted to this soil and the commercial production of improved varieties affords attractive inducements.

Because of good drainage and the ease of cultivating the crops grown on this soil, they receive better culture than the crops upon

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any of the other alluvial soils. There is a much larger percentage of it under cultivation than of any of the other types, with the possible exception of the Yazoo loam, which apparently ranks about on a par with it in this respect. By far the best farm improvements are to be found on this type.

It is valued at $25 to $40 an acre. The variation in price depends upon the improvements, the state of cultivation, and the accessibility to market. The improved areas of the type rent for $5 and $6 an acre.

The following table gives the average results of mechanical analyses of samples of this type of soil:

Mechanical analyses of Yazoo fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18632, 18634	Soil	0.0	0.6	0.4	4.0	35.4	52.6	7.1
18633, 18635	Subsoil	.0	.0	.1	1.5	23.4	69.0	6.5

YAZOO LOAM.

The Yazoo loam is the most variable type of the area. The surface soil to a depth of 8 or 10 inches consists of a rather heavy brown loam. The sand which it contains is of very fine texture and in many cases the structure resembles a silt loam more than it does a loam. The subsoil in most cases is heavier than the surface soil and consists of a drab or yellow mottled heavy loam to clay loam. It sometimes happens, however, that the surface is heavier than the subsoil. Near Benham post-office, for instance, there is a rather extensive area that has a heavy silt loam to clay loam surface 10 inches deep underlain by a light loam to fine sandy loam. The surface 6 or 8 inches may be of a very sandy nature and the subsoil almost a clay. This phase occurs in the vicinity of Stamboul post-office, where it seems to be a shallow layer of light material deposited directly on heavy clay.

The type occupies an intermediate position between the Yazoo fine sandy loam and the Wabash clay. It is generally found in narrow strips between these two types. It includes the areas where there is a gradual merging of the fine sandy loam into the clay. Frequently this change is very pronounced and there is not enough loam to indicate on the map, but, nevertheless, almost invariably there occurs a strip at least a few rods wide.

There is a somewhat different phase of this soil occurring in a few small areas along Joes Bayou ridge. Here the surface is often a very dark-brown to almost black heavy sandy loam with a yellow heavy

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loam subsoil. In the depressions it grades into a clay loam and on the higher knolls into a lighter fine sandy loam.

The Yazoo loam occupies somewhat lower ground than the Yazoo fine sandy loam and in consequence does not possess quite as good drainage. It has been formed in the same manner as the fine sandy loam type, except that deposition has taken place in somewhat stiller waters, so that the material of which it is composed is of a little finer texture.

It is adapted to corn, cotton, cowpeas, soy beans, and pecans, but is a little too heavy in most cases for vegetables and small fruits.

It should prove a more lasting soil than the Yazoo fine sandy loam, and with equally good drainage should produce fully as good yields of the crops to which adapted. It is somewhat harder to cultivate and can not be worked so soon after rains as the type first described, but with thorough drainage these disadvantages would be greatly lessened. Because of its heavier subsoil and its relatively greater fertility, it is a much better rice soil than the fine sandy loam. The phase having the lighter subsoil, however, is not to be recommended for this crop.

Cotton and corn are the principal crops grown, and the yields are about the same as on the fine sandy loam. From three-fourths bale to 1 bale of cotton is often produced without fertilization, and corn yields from 25 to 35 bushels. Rice produces 20 to 30 sacks per acre where properly cultivated.

This type is seldom sold alone, but generally in connection with larger areas of the Yazoo fine sandy loam and Wabash clay. The value placed on the type itself ranges from $25 to $40 an acre where improved. There are some good improvements on this type, but generally they are placed on the Yazoo fine sandy loam because of its higher position and relatively better drainage.

The following table gives the average results of mechanical analyses of the soil and subsoil of the Yazoo loam:

Mechanical analyses of Yazoo loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18628, 18630.....	Soil.....	0.0	0.4	0.2	1.3	3.6	72.4	22.5
18629, 18631.....	Subsoil.....	.0	.1	.1	1.2	2.3	73.4	23.

WABASH CLAY.

The Wabash clay consists of a dark-drab to nearly black surface clay soil about 6 inches deep, underlain by a plastic yellow and drab or sometimes bluish subsoil. The subsoil below 20 inches is very fre-

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quently of a lighter texture, contains considerable very fine sand, and often grades into a loam at 24 to 36 inches.

There are two phases of this type in the area, known locally as "black buckshot" and "blue buckshot" land. The former has a larger amount of organic matter in the surface and is generally better drained than the latter. The "blue buckshot" land is very flat and has a blue-drab surface soil and a heavy blue to slate-colored subsoil. The loam substratum is seldom present in this phase. The term "buckshot" is applied to this type because the surface upon drying breaks into small cubical-shaped granules about the size of buckshot.

The type is found along many of the bayous, frequently occurring as an intermediate type between the Yazoo loam and the Sharkey clay. Very often, too, it forms the entire ridge along these bayous. When found on these ridges the soil has as good drainage as the lighter types of the bottom land. On these ridges the subsoil is more likely to contain larger quantities of sand and the surface soil more organic matter. This "black buckshot" phase with its granular surface soil is more easily cultivated and yields better than the heavier "blue buckshot." Practically all the ridge along Joes Bayou is of this darker, more granular phase and has a yellower subsoil than is typical of the soil as a whole.

Like other bottom-land types it is wholly of alluvial origin. The under parts of the ridges along many of the streams appear to have been deposited in more rapidly moving water than the surface. The type in general, however, consists of a deposit laid down by rather slow moving water, and represents the third grade of alluvial soils in point of texture—the Yazoo loam and fine sandy loam being coarser and the Sharkey clay somewhat finer and more compact.

The native vegetation consists of hardwood similar to that found on the Sharkey clay. A very dense undergrowth of cane is often found on the uncleared areas.

The Wabash clay is the best cotton and corn soil of the area. In fact, the dark, granular phase—"black buckshot land"—constitutes without doubt the strongest cotton soil of the country. It is also well adapted to rice. Cowpeas, Bermuda grass, and, on the better drained areas, alfalfa should prove profitable crops. It is not adapted to fruit nor to the growing of vegetables, except perhaps onions, turnips, and the like, which do well on a heavy soil.

Cotton, the leading crop, under favorable conditions produces a bale or more to the acre, while in exceptional cases nearly 2 bales have been grown without fertilization. Corn is about the only other crop grown on this type. It yields from 25 to 40 bushels and seldom if ever receives the proper attention. Some Bermuda hay is also produced, and from 1 to 2 tons per acre are frequently cut.

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There are still considerable areas of this type uncleared. Some extensive areas were abandoned after the war and they are now covered with a dense second growth of native trees.

It often happens that this soil is worked when too wet and is invariably injured thereby. It holds water longer and consequently can not be worked as soon after rains as the lighter soils.

The selling price of this type of soil varies considerably. When improved it sells for $30 and $40 an acre, but the uncleared areas more remote from the river front can be bought for $15 to $20 an acre. In the vicinity of Lake Providence the cleared areas of the type rent for $5 or $6 an acre.

The average results of mechanical analyses of soil and subsoil of the Wabash clay are shown in the following table:

Mechanical analyses of Wabash clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18624, 18626	Soil	0.0	1.0	0.4	3.3	4.2	50.3	40.1
18625, 18627	Subsoil	.0	.3	.1	1.6	2.1	58.6	36.6

SHARKEY CLAY.

The Sharkey clay consists of 3 to 5 inches of drab to light-brown, waxy clay, underlain by a somewhat lighter drab, very tenacious clay to a depth of 3 feet or more. This subsoil often changes from a drab to a blue or slate-colored clay below 20 inches. There is very little difference between the surface and subsoil of this type.

The Sharkey clay is the heaviest soil of the area and occupies the low basinlike depression extending from the higher front lands along the Mississippi River west to the ridge of upland in West Carroll Parish. It is the most extensive type in the area, and includes fully one-half of East Carroll Parish. Crooked bayous drain a large part of this type, and continual overflow has built ridges of varying size along their courses. These ridges are always of a somewhat lighter texture than the low-lying areas between them and often constitute areas of Wabash clay. There are numerous other low, narrow cane ridges scattered through the type, which are also of somewhat lighter texture, but do not differ enough to warrant separation.

The type has been formed by alluvium brought down by the Mississippi River. Its deposition has taken place in a very sluggish current. It is all subject to overflow when the levee breaks, and often at such times much of it is covered with 8 to 10 feet or more of water. It is very poorly drained, and during most of the winter and spring months the rain water remains on the surface for long

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periods, giving to the area a semiswampy nature. Because of this poorly drained condition the type is locally termed "swamp."

The Sharkey clay is still heavily timbered with hardwood, including white ash, red gum, hackberry, cottonwood, and water, willow, overcup, and cow oak. There is also some cypress along the bayous and in the swampy depressions. The small ridges are covered with a very dense undergrowth of cane. The hardwood timber is of considerable commercial value.

This is a very fertile soil, and with proper drainage and absolute protection from inundation it could be made to produce good yields of cotton, corn, and rice. It would require such an enormous outlay to place this soil under cultivation that it appears to be beyond private means, and its development, if ever undertaken, must be carried out by some corporation with extensive resources or through the aid of State or National Government. The soil is of such a heavy nature that even with the best of drainage it will always be difficult to maintain it in good tilth.

Little if any of the type is under cultivation. It has advanced in value from $2 to $10 an acre within the last ten years. Its value is determined almost wholly by the quality of the timber growth which it supports.

The following table gives the average results of mechanical analyses of samples of this type of soil:

Mechanical analyses of Sharkey clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18614, 18616	Soil	0.0	0.2	0.2	2.0	5.2	44.6	47.4
18615, 18617	Subsoil	.0	.0	.2	1.6	6.3	50.4	41.1

RICHLAND SILT LOAM.

The surface soil of the Richland silt loam is a light-brown coarse-textured silt loam, with an average depth of about 8 inches. There is considerable very fine sand in the surface soil and it commonly merges into a very fine sandy loam. The subsoil to a depth of 15 or 20 inches is of similar texture but of a dark-yellow to reddish-brown color. Below this depth it becomes heavier, and in most cases there is a layer, 10 or 12 inches thick, of a stiff, heavy silt loam. At 24 to 30 inches the texture becomes somewhat lighter and the color commonly changes to a mottled gray and yellow. Iron concretions are frequently found below 30 inches.

The Richland silt loam occurs only in West Carroll Parish. It is the major type of the upland ridge running north and south through the parish. It occupies smaller areas in the vicinity of the Bœuf

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River in the northwest section of the parish. In the large area in the east part of West Carroll Parish the texture of the soil is remarkably uniform. The color varies somewhat, however, with the condition of drainage. Where the topography is rolling the surface is brown and the subsoil dark yellow; where level or only gently sloping, the top soil is of a lighter color and the subsoil becoms a pale yellow or mottled yellow and gray. The latter phase occurs more frequently in the southern part of the area, especially in the vicinity of Floyd. In these more level areas many iron concretions are often scattered over the surface. There is a narrow ridge of this type along the Bœuf River west of Oak Grove, and here it has a heavier subsoil and a somewhat more sandy surface. There are small spots on the tops of the higher ridges in this section that have a very fine sandy loam surface soil and a subsoil that merges into a slightly sandy clay loam.

There is a small area of about 100 acres 2½ miles south of Floyd, where the loess has been largely removed, if, in fact, it ever formed a continuous covering. At least the sand and clay of the older geological formations are largely responsible for the present soil conditions. The surface is commonly a brown fine sandy loam or loam underlain by a heavier sandy loam or sandy clay loam. The area is so variable and of such a limited extent that it has not seemed advisable to consider it a separate soil type, but rather a variation of the Richland silt loam.

The type has an undulating to gently rolling topography. It is drained by numerous broad sluggish streams with ill-defined channels. At times of heavy rainfall these slashes are not able to carry the water off rapidly enough to protect some of the lower lying areas of the Richland silt loam from overflow. These streams vary from a few rods to nearly a quarter of a mile in width. The soil along their banks is the gray Carroll silt loam, but generally the width of the type along these slashes is not great enough to indicate the bodies on the map. The higher ridges of the Richland silt loam, however, present the best-drained areas in the survey.

The type owes its origin to the weathering of the layer of loess which originally covered, in an almost continuous sheet, the uplands of the area. The present condition of this deposit is due to the continued percolation of rain water through it and the incorporation of vegetable matter by plant growth, which, together with other various forces, have changed the original deposit of yellow loess into the light-brown Richland silt loam.

This type originally supported a good growth of numerous varieties of oak and other hardwoods. Only the higher, better drained areas have been put under cultivation, so that a considerable part of the Richland silt loam is still forested.

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While it can not be considered as productive as some of the alluvial types of the area, it is a more certain soil and one adapted to a greater variety of agricultural products. It is a good Upland cotton soil, will produce fair yields of corn, and with proper attention could be made to support an excellent growth of pasture grasses. While it is not quite as early a soil as the Yazoo fine sandy loam, it is admirably adapted to vegetables. Peaches, plums, pears, and various small fruits will produce well on this soil. Cowpeas, soy beans, and lespedeza are legumes that are adapted to the type. It may be that on a few of the higher ridges alfalfa could be successfully grown, but generally it can not be recommended, as the subsoil is too often inclined to be acid and somewhat impervious.

Many of the farmers on the Richland silt loam are becoming interested in stock raising, and there is no reason why this industry should not be more extensively developed. Oats and rye would be valuable crops for winter pasture and by supplementing this pasture with root crops, such as turnips, carrots, and mangel-wurzels, stock could be wintered very cheaply. Red top (*Agrostis alba*) would prove a valuable grass for winter and spring pastures. It would be well to sow rye grass with it as a nurse crop. Orchard grass and alsike clover are also recommended for this type.[a]

Cotton and corn are the chief crops on this soil. The former averages about two-thirds of a bale to the acre, and the latter somewhere near 20 bushels, with a range of 10 to 30 bushels. Some spring oats are grown and occasionally cowpeas are sown in the corn. The farmers generally have small gardens and orchards large enough to supply vegetables and fruits for home use.

Crops receive about the same culture on this soil as on the alluvial types, although, as a rule, the farming is done in a more primitive way on the upland. Modern machinery has not been as rapidly introduced as on the other farmed types, nor are the farm improvements as extensive. It is divided into smaller farms and more often cultivated by the owners than any of the other types of the area.

The type is valued at $10 to $30 an acre, depending upon the improvements. Where uncleared it can be bought for less. It commonly rents for $4 or $5 an acre.

The following table gives the average results of mechanical analyses of typical samples of soil and subsoil of this type:

Mechanical analyses of Richland silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18604, 18606	Soil	0.0	0.4	0.6	1.6	6.4	79.6	10.6
18605, 18607	Subsoil	.0	.2	.3	.6	4.0	73.5	21.8

[a] For full discussion of southern forage plants, see Farmers' Bulletins Nos. 102 and 147, U. S. Department of Agriculture.

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CARROLL SILT LOAM.

The surface soil of the Carroll silt loam consists of 8 to 10 inches of a gray silt loam containing considerable very fine sand. Although similar in texture to the Richland silt loam, the subsoil is commonly somewhat heavier. It, too, is of a gray color, similar in this respect to the surface soil, so that there is no distinct line of demarcation between the surface soil and subsoil. The change generally comes within 10 inches of the surface, though it may be as deep as 14 or 16 inches. The subsoil is very compact and impervious, forming in many cases a distinct hardpan. Iron concretions are commonly found in this type, and in some cases they become very numerous in the subsoil.

The Carroll silt loam occurs as narrow strips of "slash" land throughout the Richland silt loam, and forms the predominating soil through the extensive flat and poorly drained areas between the west border of the large Richland silt loam ridge and the Colewa Bayou. During the spring and winter much of the type is covered with a shallow sheet of water the greater part of the time. There are numerous flat ridges and mounds a few feet in height scattered over the surface, which are of too small extent to be indicated on the soil map. The soil on these small elevations resembles the Richland silt loam in that it has a light-brown surface soil and a pale-yellow subsoil. The subsoil, however, becomes a gray silt loam in most cases below 24 inches. The greater part of the type is subject to inundation by the back waters from the Mississippi River when the levee breaks. The numerous slashes throughout the type contain water much of the time.

While it appears that this type owes its origin partly to alluvial deposition, it seems very probable that it was formed at the same time and in the same manner as the Richland silt loam, but on account of its subsequent undrained condition it has acquired characteristics very distinct from those of the Richland silt loam.

Practically none of the Carroll silt loam has ever been put under cultivation. It is still covered with a heavy growth of Spanish, black jack, red, and post oak, and often a dense undergrowth of palmetto. It would require a large expenditure to put this type in condition for cultivation. Because of its low humus content and its often impervious subsoil, it would not, even with the best of drainage, prove a good cotton or corn soil. For a few years after being put under cultivation it should give fair yields, but the yields could hardly be expected to continue profitable for any considerable length of time. It might be utilized to some extent for rice production and at the present time this seems to be the best agricultural crop to produce on this type, though even its economical production seems somewhat questionable. Probably the best means of utilizing much of this type is to allow it to remain in forest. It supports a good

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growth of commercial hardwood at present, and by careful and systematic cutting of the mature trees returns can probably be secured that will equal if not surpass those from any farm crop.

Much of the type is owned by a large cooperage company which has recently begun to remove the larger timber. The farmers utilize the soil of this type to some extent for pasturing hogs.

The Carroll silt loam is valued at $10 to $12 an acre, principally because of the timber upon it. The few areas that have been cut over can be bought for $500 to $700 a quarter section.

The average results of mechanical analyses of this type of soil are given in the following table:

Mechanical analyses of Carroll silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18618, 18622.....	Soil.....	0.1	0.2	0.1	1.2	9.4	71.3	17.9
18619, 18623.....	Subsoil.....	.0	.1	.2	.6	6.9	60.1	32.0

WAVERLY SILT LOAM.

The Waverly silt loam consists of a mottled drab and yellow clay loam and silty clay surface soil about 5 inches deep, underlain by a light drab or gray and yellow silty clay loam subsoil which often grades into a clay below 20 inches. This type is lighter in both color and texture than the Wabash and Sharkey clays.

It occupies the alluvial lands along Boeuf River and extends as far east as Colewa Bayou. The type is heavier near the river and becomes very light near the east boundary, where it often grades very gradually into the Carroll silt loam. In the vicinity of this boundary the type may have a gray or light-drab, heavy silt loam subsoil, a shallow clay loam layer having apparently been deposited on the material giving the Carroll silt loam.

The Waverly silt loam is flat, with a few low cane ridges through it. It possesses very poor drainage and is subject to occasional inundation. Very little of it, however, is flooded except when the levee along the Mississippi River breaks, at which times the backwater comes in, and this, together with that of the Boeuf River, floods the whole surface of this soil.

It is of alluvial origin and has been laid down in a rather sluggish current. The alluvium has apparently been carried down largely by the Boeuf River, but probably would not have been so widely distributed were it not for the influences of the backwaters of the Mississippi.

The type is covered with a dense timber growth consisting largely of oak. There is an occasional undergrowth of scrubby cane and

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palmettos. If drained and protected from inundation, this type would produce good yields of cotton, corn, and rice. It would require a considerable outlay, however, to put it in shape for cultivation.

Its value is determined largely by the timber to be found upon it. It is held at $10 to $12 an acre at the present time, which price represents a considerable advance in value during the last ten years.

The following table gives the average results of mechanical analyses of samples of the soil and subsoil of this type:

Mechanical analyses of Waverly silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18610, 18612.....	Soil.....	0.0	0.6	0.4	2.3	8.7	63.5	24.5
18611, 18613.....	Subsoil.....	.0	.3	.4	1.5	8.1	60.9	29.0

BOEUF FINE SANDY LOAM.

The surface soil of this type is a brown loamy sand, about 8 inches deep, underlain by a heavy, plastic, sandy clay subsoil of yellow color. The line of division between the top soil and the subsoil is very marked. The soil generally becomes lighter in texture at 30 inches, and occasionally a sandy loam is found just below this depth.

It is of very limited extent and occurs only on a few small ridges in the vicinity of the Boeuf River. The tops of these ridges are from 15 to 30 feet above the surrounding area. Their location seems to indicate that they might be of alluvial origin, but the character of the soil hardly justifies such a conclusion. The lower parts of these ridges frequently merge into the Richland silt loam, and in one instance a part of one of these ridges was found to be Richland silt loam and the remainder of it Boeuf fine sandy loam. The Richland silt loam seems to possess a heavier subsoil throughout the extreme western part of the area, and on the very highest ridges little patches occur where the surface is of a sandy nature. It seems that the loess deposit becomes very thin in this section of the area, and that on these ridges it has been eroded, exposing the sandy substratum which has given rise to this soil.

The Boeuf fine sandy loam is a very productive soil, and much of it is under cultivation. It produces from one-half to nearly a bale of cotton and as high as 30 or 40 bushels of corn to the acre. There are probably some small uncleared ridges of this soil which could not be located on the soil map, as their extent was difficult to determine on account of their heavy forest covering.

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The following table gives the results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Boeuf fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18602	Soil	0.0	1.0	14.5	29.0	4.8	40.9	10.0
18603	Subsoil	.0	1.0	14.1	31.3	4.2	32.2	17.0

DRAINAGE.

Fully two-thirds of the two parishes is insufficiently drained to allow agricultural development, and much of the area that is at present under cultivation would be greatly improved by better drainage. There has been a little ditching done here and there on the better managed plantations, but in no case, so far as known, has any drainage district been organized or any other united attempt made to drain systematically any considerable section.

Throughout the alluvial portion of the two parishes the water table is found within a few feet of the surface during much of the year, while in the lower lying types it is practically at the surface throughout the winter and spring months.

The plantations along the river front suffer considerable injury from seepage water, which percolates through the levee whenever the river rises to a considerable height. This seldom becomes injurious to land more than a quarter or half a mile from the levee. This condition seems to be unavoidable and will probably exist until ditches are cut through this higher front land so that seepage can drain to the lower lying land to the west.

The thorough drainage of the extensive areas of so-called "swamp," which includes practically all of the Sharkey clay, the Carroll silt loam, and the Waverly silt loam, as before mentioned, would require too large an outlay to be met by private means, and such a project will very likely have to be carried out by some corporation or through Government aid. There are numerous natural drainage ways to be found throughout these low areas, but they must be broadened and deepened, and in some cases straightened, before they will be able to carry water from the area through which they flow.

While the drainage of much of the two parishes seems to be too large an undertaking for private individuals, there is no reason why the drainage of certain areas can not be easily improved. By the forming of drainage districts along certain of the bayous, the combined effort of the different landowners could do much in at least preserving what natural drainage now exists, and there is no reason

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why the logs and trees could not be kept from accumulating in these bayous, which possibly could be deepened also in some cases. Instead, some of the landowners have run open ditches into the bayous, which have continually deposited sediment at their entrance until the bayous have become shallower and in some cases even partly dammed by such sediment.

The permanent agricultural development of much of the area can only come about through absolute protection from inundation, followed by thorough and systematic drainage.

SUMMARY.

East Carroll and West Carroll parishes are located in the extreme northeastern part of Louisiana and have a combined area of 727 square miles. The surface of the area is generally very flat and is largely subject to inundation when the levee along the Mississippi breaks. There is an upland ridge which is mostly above overflow extending north and south through West Carroll Parish.

The area drains south into Red River. Fully two-thirds of these two parishes is still in forest and insufficiently drained. The front land along the Mississippi River, the ridges adjacent to some of the bayous, and the upland ridge in West Carroll Parish include most of the improved areas.

The negroes outnumber the whites nearly ten to one in East Carroll, but in the West Carroll Parish the white population is slightly in excess. Lake Providence is the only town of importance in the area.

The climate is that of the warm temperate region of the United States. The winters are short and mild; the summers long and hot. The rainfall is sufficient for successful crop production.

The value of the agricultural products of the area is far less than before the civil war. Cotton and corn are the leading crops. Some rice is being successfully produced near the Mississippi River. The plantation system of farming is commonly practiced in the east part of the area, while the white people often do their own farm work on the upland ridge. The negro is the only available farm laborer.

The well-improved lands are valued at $20 to $30 an acre, while the timbered areas can be bought for $10 and $12.

The greater part of the area is of alluvial formation. The upland ridge that extends the entire length of West Carroll Parish is covered with a thick sheet of loess.

Ten distinct types of soil were mapped in the survey. The Yazoo fine sandy loam occupies the higher, better drained areas of the Mississippi River bottom land. Generally this soil is rather light for corn production. Cotton gives good yields and the type is especially well adapted to vegetables.

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The Yazoo loam is heavier and forms an intermediate type between the Yazoo fine sandy loam and the Wabash clay. It is adapted to corn and cotton, and where the subsoil is heavy it makes an excellent rice soil. It is located on the front lands and along the bayous of East Carroll Parish.

The Wabash clay is locally termed "buckshot land." When well drained it is the most productive soil type of the area. Cotton often yields over a bale to the acre and corn from 30 to 40 bushels. It also gives good yields of rice. The lower areas are rather poorly drained.

The Sharkey clay is the heaviest soil of the area. It is locally termed "swamp," because of its poorly drained condition. It supports a heavy timber growth.

The Richland silt loam is the most important type derived from the loess deposit. It is found only on the upland ridge in West Carroll Parish. Cotton and corn are the principal crops grown, and fair yields are obtained, though not so large as on some of the alluvial types. It is well adapted to the production of fruit and vegetables.

The Carroll silt loam occupies the poorly drained areas of the loess ridge. It is of a gray color and commonly has an impervious and somewhat acid subsoil. It is practically all in timber.

The Waverly silt loam includes most of the alluvium along the Boeuf River. It is flat, poorly drained, and all of it is heavily timbered.

The Boeuf fine sandy loam and the Yazoo coarse and fine sands are the other types of the area. They are of limited extent.

The greater part of the two parishes is insufficiently drained to allow agricultural development. The thorough drainage of the area is too extensive an undertaking to be accomplished by private means, and must be undertaken, if at all, by some corporation or with Government aid.

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SOIL SURVEY OF THE CORPUS CHRISTI AREA, TEXAS.

By A. W. MANGUM and H. L. WESTOVER.

DESCRIPTION OF THE AREA.

The Corpus Christi area is located on the Gulf coast in the southern part of the State of Texas in the northeastern part of Nueces County, and comprises 232,192 acres or about 363 square miles. It is bounded on the north by Nueces Bay and the Nueces River, which here forms the boundary between Nueces and San Patricio counties, on the east by Corpus Christi Bay and by the Laguna Madre, which

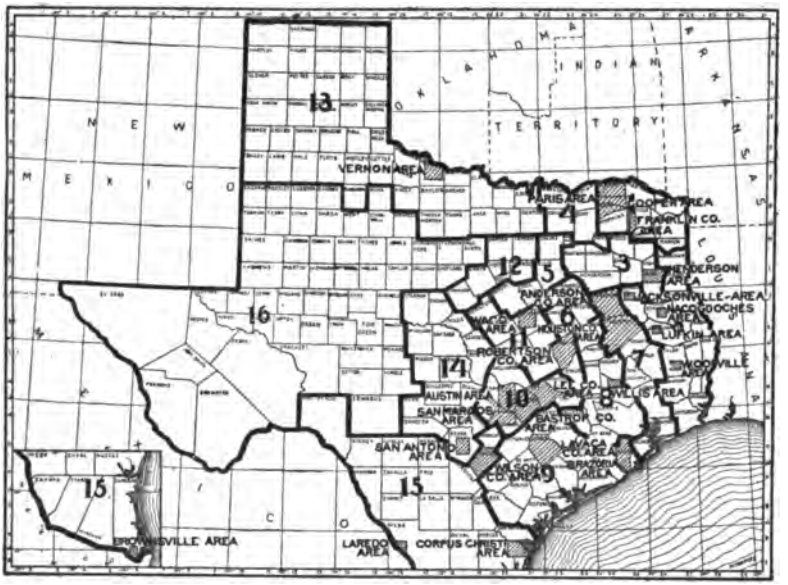

FIG. 23.—Sketch map showing location of the Corpus Christi area, Texas.

is a broad body of water lying between Padre Island and the mainland, and on the south and west by that part of Nueces County not included in the survey. The principal topographical features of the area consist of the broad level plains, the gently rolling hills adjacent to the river valley, and the low, flat delta lands which have been formed at the mouth of the Nueces River. The greater part of the area has the general appearance of a perfectly level plain, but low mounds and gentle swells give it, as a whole, a very gently undulating topography.

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In the western part some of the low mounds or ridges reach an elevation of 75 to 80 feet above sea level, but this section is a comparatively level plain which slopes gently eastward toward the Gulf and ends abruptly at the narrow strip of level sand on the shore of the bay in a steep bluff, often more than 30 feet high. This broad plain was formerly an open prairie, supporting a heavy growth of native grasses, but during comparatively recent years the greater proportion of it has been covered by a thick growth of mesquite and cactus. Several large, open prairies, however, are found in the extreme southern and southwestern sections of the area, though these are also rapidly being covered with a low growth of running mesquite and cactus.

The topography of the uplands bordering the valley of the Nueces River is more rolling than that of the country situated farther back from the stream, although the summits of the rounded hills seldom reach an elevation equal to that of the higher knolls of the comparatively level plains. The hills are low and rounded and the intervening valleys are usually quite narrow. However, no deep gullies have been formed and the sandy soils have suffered very little from erosion, even along the steeper hillsides.

The land occupying the lower valley of the Nueces River, as well as that bordering Nueces Bay, is almost level, but low ridges or shallow depressions sometimes are encountered, causing it to have a gently undulating topography. These low "flats" have only a slight elevation above sea level and at times of high water are subject to overflow by the river. In some places the course of the river approaches the rolling uplands and the valley becomes very narrow or disappears altogether. The most extensive "flats" have been formed near the mouth of the river, where it empties into Nueces Bay, but the greater area of the low delta land occurs on the northern side of the stream just outside of the area.

There is a small peninsula in the eastern part of the area lying between the inlet at the mouth of Oso Creek and the Laguna Madre. The topography of this section is comparatively level, except along the northern coast, where a series of large sand dunes have been formed by the action of the winds. This peninsula is covered by a dense growth of scrub oak and other native vegetation.

With the exception of the low, flat lands which occur in the lower valley of the Nueces River and border Nueces Bay, the area as a whole is fairly well drained. The northern part of the area is drained by the Nueces River. This stream is perennial, but has no large tributaries within the area. Oso Creek in the south-central part of the area follows a general southeasterly course, emptying into an inlet of Corpus Christi Bay in the southeastern section of the area. This

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stream is dry during the greater part of the year, but it has cut out a deep channel through the soft clay formation, and during times of heavy rainfall it serves as an outlet for the drainage from the lands bordering it. The extreme southwestern corner of the area is crossed by the Petronilla Creek. This is also an intermittent stream, but at times of rainfall it drains considerable land in the western and southwestern parts of the area.

There were very few settlers in the area prior to 1850, but during the decade 1850 to 1860 there were a number of settlers who came from England, Scotland, and Ireland and others from the older settled districts of Texas and from some of the northern and eastern States. From 1860 to 1900 the settlement of the area progressed very slowly, but during the last eight years (1900–1908) the population has increased very rapidly.

The agricultural development during the last five years has attracted many more settlers from the northern and eastern States, and at the present time (1908) the land is being taken up very rapidly by farmers from all parts of the United States. The majority of the farmers now settling in the area, however, come from Nebraska, Wisconsin, Illinois, Kansas, Iowa, Minnesota, and other Middle Western States.

The present population of the area also includes a large number of Mexicans. These are mainly the descendents of the Mexicans who inhabited this part of Texas before it was annexed to the United States. The greater proportion of the Corpus Christi area is very sparsely settled. During the last few years agricultural development has resulted in the rapid settlement of some parts, especially the lands adjacent to Corpus Christi and some of the smaller towns, which are now comparatively thickly populated; but the large cattle ranches in the southern and southwestern parts of the area are at present inhabited only by a few men engaged in stock raising. The more thickly settled districts are found along the main public roads, especially those leading south from Corpus Christi and the road following the valley of the Nueces River.

Corpus Christi, the county seat of Nueces County, situated on Corpus Christi Bay, in the southeastern part, is the principal town in the area and has a population of about 10,000. Robstown, in the western part of the area, at the junction of the St. Louis, Brownsville and Mexico Railway and the Texas Mexican Railway, and Calallen, situated on the St. Louis, Brownsville and Mexico Railway, in the northwestern part of the area, are also shipping points that are becoming of considerable local importance. The area around Corpus Christi, where most of the agricultural development has taken place,

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is traversed by a well-kept system of public roads, but the roads have not yet been permanently established over much of the survey.

The St. Louis, Brownsville and Mexico Railway traverses the western part of the area and has a branch line extending into Corpus Christi. The Texas Mexican Railway, which extends from Corpus Christi to Laredo, Tex., crosses the central part of the area, and the northeastern section is traversed by a branch of the San Antonio and Aransas Pass Railway. These roads furnish means for quick transportation of all products of the area to the larger Texas markets and to northern and eastern States. Corpus Christi is the local market for all products.

Before the early vegetable crops are ready for shipment in carload lots small shipments are frequently made by express to the larger cities of northern Texas, to St. Louis, Kansas City, Denver, Chicago, and other northern markets. Almost the entire cabbage crop is shipped to markets west of the Mississippi River. The earlier shipments are usually sold on the more important Texas markets, but the greater part of the crop is shipped to the larger northern markets, such as Kansas City, St. Louis, Chicago, Denver, and St. Paul. A large part of the onions and cucumbers not sold on the Texas markets are shipped to Cincinnati, Cleveland, and Pittsburg and to the larger markets west of the Mississippi. San Antonio, Dallas, Fort Worth, Houston, Austin, and other Texas cities offer a ready market for the earlier shipment of truck, and also for the small shipments for the Christmas markets. Fort Worth is the principal market for all of the stock raised in the area, but a few are annually marketed at Kansas City and Chicago.

CLIMATE.

The climate is semitropical, and owing to the situation of the area on Nueces and Corpus Christi bays the temperature of this section, more particularly that part adjacent to the coast, is modified to a marked degree during both the winter and summer seasons by the prevailing Gulf winds. Farther inland, however, the moderating effects of the sea breezes are not so much in evidence, and as a result the thermometer falls lower in the winter and rises higher in the summer, while the air is naturally somewhat drier.

The prevailing winds are from the southeast during every month in the year except January and December, when they are northerly. These winds have a tendency to dry out the soil after each rainfall, and care should be taken to form a dust mulch on the surface by stirring the soil after each shower to conserve the moisture. During the summer months, shortly after sunrise, a fresh wind starts in from the

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Gulf and continues for the remainder of the day and far into the night. These winds begin in March and last until November, alleviating the heat during the warm months. In December, January, and February cold north winds, locally known as "northers," occur at intervals of one to two weeks, and the temperature frequently drops several degrees in a few hours. These winds, coming in contact with the moisture-laden air from the Gulf, very frequently cause a fall of rain, and in such cases there is usually little danger of frost. It is only during a dry "norther" that vegetation is greatly endangered by a freeze. These "northers," however, seldom last more than two days, when the weather again becomes very mild and delightful, and remains so for several days. Because of this uniformity in temperature during all seasons, this section is rapidly becoming a great winter resort for northern people and a summer resort for the Texans from the interior of the State.

According to the records of the Weather Bureau station at Corpus Christi, the average annual rainfall for the past twenty years has been 27.18 inches. The highest monthly average for the same period is 4 inches for the month of September, while the lowest was 0.32 inch for December. Aside from these variations the rainfall is fairly well distributed throughout the year.

The temperature is remarkably uniform, there being in a nineteen-year average, according to the records of the Weather Bureau station at Corpus Christi, a difference of only 29.2° between the average for January, the coldest month, and July, the hottest. The average temperature for July for nineteen years is 82.70° F., while the highest ever recorded in this or any other month was 98° F. Only at rare intervals does the thermometer go above 90° or 95°. The average temperature for January during this same period was 53.5° F., although in a few cases the thermometer has gone as low as 16° or 18°, but a temperature lower than 27° or 28° is unusual, and only once in four years, on an average, has a killing frost been recorded in this the coldest month.

During the twenty years that the Corpus Christi Weather Bureau station has been in operation the average date for the first killing frost was December 25 and for the last killing frost February 27. The earliest date of a killing frost ever recorded is November 30 and the latest recorded is March 19.

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The following table gives statistics of weather, compiled from the records of the Weather Bureau station at Corpus Christi:

Normal monthly, seasonal, and annual temperature and precipitation, Corpus Christi.

Month.	Temperature.			Precipitation.			
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year.	Total amount for the wettest year.	Snow, average depth.
	°F.	°F.	°F.	Inches.	Inches.	Inches.	Inches.
December	58	86	20	1.3	0.4	0.9	0.0
January	56	82	16	2.3	0.8	1.9	0.4
February	58	88	11	2.2	1.3	3.5	0.3
Winter	57			5.8	2.5	6.3	0.7
March	64	96	28	1.8	0.1	3.0	0.0
April	70	92	44	1.5	0.4	1.4	0.0
May	76	96	44	2.7	1.4	8.7	0.0
Spring	70			6.0	1.9	13.1	0.0
June	80	97	59	2.6	1.0	5.5	0.0
July	82	98	68	1.8	1.3	2.2	0.0
August	82	98	65	2.4	2.5	2.2	0.0
Summer	81			6.8	4.8	9.9	0.0
September	79	97	54	3.9	7.2	7.2	0.0
October	73	91	42	2.0	0.4	2.9	0.0
November	64	89	20	2.3	0.7	8.6	0.0
Fall	72			8.2	8.3	18.7	
Year	70	98	11	26.8	17.5	43.0	0.7

AGRICULTURE.

From the date of the first settlement to comparatively recent years stock raising was the predominating agricultural industry, and this whole section was formerly one broad, open range for cattle. The stock was branded by the owners and allowed the freedom of the open prairies, but later, when the barbed-wire fences came into general use, the large pastures were fenced off and more attention was given to the improvement of the stock.

The raising of sheep was a very important industry during the early seventies and a large quantity of wool was annually exported from the area, but during the decade 1880 to 1890 this industry began to decline and was finally abandoned, the larger pastures being utilized exclusively for the raising of horses and cattle.

During the last ten years the number of cattle raised in the area has fallen off considerably. This is mainly due to two causes—first, the rapid agricultural development which has taken place in recent years has caused the land near the local markets or within reach of the local shipping points to become too valuable for trucking and

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general farming to be utilized for pasture; second, a large proportion of the land which formerly supported a heavy growth of native grasses has become covered with a dense growth of mesquite, cactus, and other native vegetation, making it of little value as a range for cattle. Stock raising, however, is still an important industry and is carried on extensively in both the south and southwestern sections.

The beginning of the real agricultural development is of comparatively recent date. As long ago as 1880 there were a few farmers engaged in truck growing on the lighter soil along the Nueces River. The areas under cultivation, however, were small and the crops produced were not more than enough to supply the demands of the local markets. From this time up to about 1890 or 1892 there was very little increase in the acreage under cultivation.

About 1892, however, the growing of truck on a more extensive scale to supply outside markets was begun in the Sunshine country south of Corpus Christi, and the success of this enterprise resulted in a rapid increase in the acreage devoted to these crops. The agricultural development of the area, however, progressed very slowly until about 1902 or 1903, as it was not until that time that the real value of this section of the State for truck growing was recognized. The growing of cotton began about 1903 and this has become the principal general farming crop of the area. Sufficient corn is usually produced for local use, while the growing of early vegetables easily ranks as the principal industry in the area at the present time.

The importance of this country as a truck-growing section depends mainly upon the earliness with which crops can be marketed. When areas farther north are marketing their own vegetables, attention here is given to growing cotton, corn, and forage crops.

Up to the present time no irrigation of any consequence has been practiced. Water can be obtained from the Nueces River by pumping to irrigate a considerable area. So far attempts to obtain water for irrigation from artesian wells have not been successful. Well water is found at comparatively shallow depths throughout the area, but is usually brackish. With proper methods of cultivation the rainfall is sufficient to produce good yields.

The climatic conditions of the area are such that farm operations can be carried on every month in the year, while two and sometimes three crops may be grown on the same field in a single year. This practice, as a rule, is not advisable, since better crops and more profitable yields can be secured if, after the removal of one crop, time and attention be given to conserving the moisture for the next year's crop.

The principal truck crops grown at the present time are cabbage, cucumbers, onions, beans, peas, lettuce, beets, radishes, sweet and Irish potatoes, cauliflower, carrots, and spinach.

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Cabbage, which is grown to a greater extent than any of the other truck crops, as a rule gives the largest returns. It has the advantage of being a crop which seldom fails to give profitable yields, and there is always a good market for it. As is the case with all other crops, however, the yield depends largely upon the rainfall. On the average about 15,000 pounds per acre are obtained. The seed are sown in the fall, from September to November, in drills 3 to 3½ feet apart, and when the young plants have attained sufficient size they are thinned out to about 18 to 24 inches apart. Transplanting is practiced to a limited extent, but in the operation the taproot is liable to be destroyed, and such plants seem to be unable to withstand drought as well as those that have been undisturbed. If a dry period happens to occur just at the time when it is desired to transplant, many plants will be lost or the work so delayed as to make the crop mature later, which means a lower price and consequently less profit. Harvesting usually begins the latter part of January, the first carload shipment being made early in February and continuing until late in April. The varieties which seem best adapted to the soil and climatic conditions of the area are the Flat Dutch and Ideal. The Winningstadt and Early Jersey Wakefield are also grown to some extent, but as these varieties have pointed heads instead of flat they are not so marketable.

Onions are grown quite extensively and are second in importance of the truck crops. They are sown in drills 14 to 18 inches apart, from September to November, and after having made a good start are thinned out to about 2 to 4 inches apart. Harvesting begins the latter part of March and continues until the middle of May. The average yield is about 7,000 to 8,000 pounds per acre. There is usually a ready sale for the crop at good prices. The white Bermuda is the principal variety grown.

A small acreage of Irish potatoes is annually put in. The crop is planted in January, and harvesting begins about three months later, usually during the latter part of March or early in April. The yield averages from 50 to 75 bushels per acre, and the crop brings high prices—usually $1.50 to $3 per bushel. The Bliss Triumph is the variety most commonly grown.

Cucumbers are probably next in importance to cabbage and onions. They are planted from February 15 to March 15 in rows about 4 or 5 feet apart, and the plants are subsequently thinned out to three in a hill. Marketing begins the latter part of April. The average yield of the crops is hard to estimate, but is said to be about 100 bushels per acre. The improved White Spine seems well adapted to the soils and climatic conditions, and is the variety commonly grown.

A considerable acreage is annually devoted to beets, carrots, and turnips. The seed are sown in October and November, and harvesting

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on a large scale begins late in February. Small shipments are frequently made for the Christmas market. These crops do very well, and a profitable yield can usually be depended upon, but the market is rather uncertain. In some years there is no difficulty in disposing of the entire crop at a good profit, while in other years there is little demand.

Peas and beans are grown for both the fall and spring markets. The fall crop is planted in September, and is usually marketed before Christmas, although in some seasons the first frost is so late that the marketing continues until about January 1. The spring crop is planted in February, and is marketed the latter part of March or early in April. The principal varieties of beans grown in the area are the Black Wax and Valentine, nearly all of which are sold for string beans, comparatively few shell beans being grown. From 100 to 200 bushels are harvested from an acre. A small acreage is put in peas each year. Only the extra early varieties are grown. Both peas and beans have proved very profitable crops to the truck growers.

Tomatoes are grown very successfully, especially on the lighter textured soils. The seeds are planted in hotbeds about the 15th of December, and the plants are removed to the cold frame about the middle of January. The date of setting the plants in the field depends largely on the weather, but is usually about the 20th of February. The first crop will then be ready for gathering about the 1st of June. As a rule tomatoes yield well and bring a very fair price, and as there is always a ready market for them they are a very desirable crop. The Dwarf Champion is the favorite variety with a large number of the farmers.

Sweet potatoes and melons have been grown in favorable seasons; very fair yields are obtained on the sandier soils. Large yields, however, require irrigation.

Cauliflower has been grown to a very limited extent, but for some reason has not met with general approval. Lettuce does very well, especially on the Victoria loam, and large shipments are made throughout the winter season. Radishes and eggplant are very successful crops, though as yet no large shipments have been made.

A small acreage is sown in oats for winter pasturage. Kafir corn and sorghum cane have also some importance as forage crops. A few farmers grow enough corn for their own use. The best results are obtained from the Mexican corn, which seems to be well adapted to the soil and climatic conditions. The average yield is about 20 to 30 bushels per acre.

Cotton does well, especially on the Victoria clay and Victoria loam. It is usually planted in February and March and picking begins early in July. The crop should be put in as early as possible, as the early

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maturing crop is not so liable to be damaged by the boll weevil as that maturing later in the season. For this reason it is not generally advisable to plant cotton late in the spring as a second crop on the land used for early truck. The early crop has the additional advantage of being on the market earlier in the season, when the price is usually high. The yield per acre varies considerably, as it is influenced by the season, type of soil, and methods of culture used. The average is one-half bale to 1 bale per acre, and as much as 1½ bales per acre has occasionally been reported.

Cowpeas thrive on all types of soil, and this crop is beneficial, keeping the soil in a productive state, especially in case of the lighter types, such as the Victoria fine sandy loam and Nueces fine sand. The experience of the truck farmers shows that where cowpeas are grown and turned under larger yields are obtained than from the new lands when cultivated for the first time.

Fruits such as figs, oranges, lemons, and peaches are grown to such a limited extent that up to the present time nothing definite is known in regard to the local adaptation of soil and climate to these products. There are only a few fig trees in the area, yet just outside of the area and on a soil similar to the Victoria clay there is a large orchard of fig trees in a flourishing condition and giving fair yields. The few orange and lemon trees seen are apparently doing well.

The greater proportion of the farming land in this area has been under cultivation for such a short time that very little attention has been paid to the particular adaptation of crops to the various types of soil, but it is generally recognized that the Victoria clay is the most productive soil and makes the best land for cabbage, cotton, and general farming. Onions are better adapted to the Victoria loam, while tomatoes do better on the Victoria fine sandy loam. When fertilizer is used and careful cultivation given, the Nueces fine sand seems well adapted to melons and sweet potatoes.

As a rule no definite system of rotation is practiced in the area, though it is generally recognized by the farmers that crops do better when some system of rotation is followed. In a few cases the land is under cultivation the whole year and as soon as one crop is harvested another is planted. After the spring crop of peas or beans has been marketed the land is often put in corn, cotton, or sorghum, which will mature in July or August. The land is then plowed and the fall crop of peas or beans is planted. Another and more common practice is to plant cotton after the early crop of cabbage has been harvested.

Many farmers do their plowing in July and August, but a better method for this section and one that is followed by a number of the most successful farmers is to go over the land with a disk harrow as soon as the crop is removed, whatever time of year this may be. After this the land receives a disk harrowing after every rain, or at

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least often enough to keep the weeds down. Just before planting the land is plowed, after which it is gone over with a disk harrow and finally with a smoothing harrow. This method keeps the soil in condition to absorb any rain that falls and at the same time prevents excessive loss of soil moisture by evaporation.

The depth of plowing varies, but is usually from 4 to 6 inches. The breaking is generally done with sulky disk plows drawn by three or four mules, although many farmers still use the walking moldboard plow. Gang plows drawn by steam or gasoline engines are being used to a limited extent. Cultivation begins as soon as the crop has attained sufficient size and is kept up at intervals of eight to ten days throughout the season, until the crop is harvested. These cultivations are shallow, being just deep enough to keep a dust mulch on the surface at all times, thus preventing the excessive loss of moisture by evaporation. It is necessary to hoe many of the crops several times during the growing season in order to keep out the weeds which grow up rapidly between the rows. Comparatively little commercial fertilizer has been used up to the present time (1908), but it is now gradually coming into use on the sandy soils. Applications on these soils range from 300 to 600 pounds an acre.

The labor employed on both the farms and cattle ranches is largely Mexican, is fairly efficient, and usually plentiful at all seasons. The farm laborers receive from 75 cents to $1 a day with board, and when hired by the month from $15 to $20.

The cost of clearing the land of mesquite, cactus, and other vegetation varies from $7 to $25 an acre. Where the small bushy growth known as running mesquite occurs the cost is seldom less than $10 to $15 an acre, as this variety of mesquite has an extensive root system which must be removed before the land can be put under cultivation. Mexican laborers frequently take contracts for clearing large tracts of land at a stipulated price, varying from $8 to $25 an acre, according to the character of the growth.

The area includes parts of several cattle ranches which have not yet been divided into smaller tracts or developed agriculturally. Some of these ranches contain from 100,000 to 200,000 acres. In the more thickly settled districts, however, where the greatest agricultural development has taken place, the larger ranches have been divided into tracts of 20 to 200 acres. Some of the larger farms, where cotton and other staple crops as well as truck are produced, now have several hundred acres under cultivation, but the average truck farmer seldom cultivates more than 35 or 40 acres, and many near the local markets are profitably handling a much smaller acreage than this. A very large percentage of the truck farms in the area are operated by the owners. In addition a small acreage is annually rented for truck growing, the price being $8 or $10 an acre.

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On the larger farms, farther away from the local markets, a considerable acreage is cultivated by tenants, who farm the land on shares. In most cases the landowner furnishes nothing but the land and receives one-fourth of the cotton and one-third of the grain produced. If the landowner also furnishes the seed, work animals, and farming machinery he receives one-half of the crops.

The value of the farm lands of the area varies considerably with the location of the land, the character of the soil, and the character of the improvements. Unimproved land at a distance from the local shipping points and markets is valued at $15 to $40 an acre, while some of that highly improved, in a good state of cultivation, and located near the local markets and shipping points, is valued at $150 to $200 an acre.

Deep plowing, shallow surface cultivation at frequent intervals, and the use of some system of crop rotation in which cowpeas are included are methods suggested to improve the soils of the area. Stable manure will also be found very beneficial both in increasing the productivity and improving the physical condition of most of the soils in the area.

SOILS.

The soils encountered in the Corpus Christi area may be separated broadly into three classes—those derived mainly from the clay marl and calcareous clay formation which underlies the broad, comparatively level plains; those derived from lighter deposits of sand which have been laid down on the older formations during recent geological time; and the alluvial deposits laid down along the valley and at the outlet of the Nueces River. The calcareous clay formation is found beneath the greater part of the level upland sections of the area and has an average thickness of several hundred feet. This material weathers very rapidly, forming a heavy black clay soil, locally known as "black land" or "hog-wallow land," which occupies a very large proportion of the survey. When bodies of this soil border those of a light sandy texture a considerable quantity of fine sand has drifted over the level plains and become mixed with the heavier material, forming a dark-brown loam which contains considerable sand in the surface 10 to 12 inches, but rapidly becomes heavier with depth. Areas of loam often occur which are not adjacent to areas of fine sand or fine sandy loam. These loamy spots are probably the remains of old sand ridges or dunes, the fine sand having been deposited over the calcareous clay by the action of the winds. This loamy soil, which has been classed as Victoria loam, represents the intermediate type between the heavy black clay, indicated on the soil map as Victoria clay, and the fine sandy loam, mapped as Victoria fine sandy loam. The large area of fine sandy loam extending across the northern part of the survey and bordering the bluff which at one time

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formed the coast of Nueces Bay also owes its origin to sand drifts, formed along this old coast line by the winds.

Small areas of drifted sand are sometimes encountered farther back from the coast, but a large part of the fine sand has been carried away by the winds and redeposited over the adjacent areas of heavy clay, forming small bodies of Victoria loam and leaving only a shallow deposit of fine sandy loam capping the summits of the low mounds. The small peninsula in the southeastern part of the area is covered by a deep deposit of wind-blown sand and a series of large sand dunes has been formed along the northern coast. The eastern side of this peninsula forms the coast of the Laguna Madre, and the sand here has been drifted inland and covers the underlying formation of clay to a depth of many feet. There is only a very narrow strip of beach sand at the base of the bluff which forms the coast line of the greater part of the area, but a large proportion of the small peninsula in the extreme northeastern corner of the area consists of a narrow beach of sand and shells which has been formed by the action of the waves. Several other small beaches of like character occur along Nueces Bay. These beaches are composed of a compact mass of sand and shells, cemented with lime, but they are of limited extent and of no agricultural value.

The soil occupying the low, poorly drained "flats" that lie near the outlet of the Nueces River and border Nueces Bay has been formed by the gradual filling up of the shallow bay by material held in suspension by the waters of the river. The large quantity of silt and clay brought down by the waters of the river was deposited in the shallow waters of the bay, eventually building up broad clay "flats" which later became covered with a growth of coarse marsh grasses. As this deposition of silt and clay continued, the extent of these salt marshes gradually increased and the surface of the area laid down early in the formation of this delta was gradually built up above the level of the bay. A large quantity of material was carried out by the currents and deposited in the shallow water along the shores, eventually forming the low semimarshy land which borders the bay on each side. A large proportion of these low "flats" has at present only a slight elevation above sea level and is very poorly drained and subject to overflow from the river, though it is never covered by the waters of the bay. Alkali is often found in this soil in sufficient quantity to be harmful to crops, and this together with its poor natural drainage makes it of little agricultural value.

The soil which occurs farther up the valley of the Nueces River is very closely related to that occupying these poorly drained flats, as it also owes its origin to the deposition of silt and clay by the waters of the river. The material forming the soil, however, was deposited

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along the old flood plain of the stream at times of overflow and was not primarily laid down in the salt waters of the bay. This land is also subject to overflow and has poor natural drainage, but is comparatively free from alkail.

Seven types of soil, including the Coastal beach, were encountered in the survey. Several of these types are very similar to some found in other sections of the State, both as to texture and geological origin. The Victoria clay in this area is quite similar in texture and topographic features to the heavy black clay found in the Austin, Waco, San Marcos, and other areas of Texas. The Victoria loam in this area also has many of the characteristics of the soils of similar origin found in some other Texas areas. It usually occurs wherever the black clay soil grades into those of a light sandy character. The Lomalta clay, occupying the poorly drained areas along Nueces Bay and the low valley of the Nueces River, is similar in texture, origin, agricultural value, and drainage conditions to the soil mapped as that type in the Brownsville area, Texas. The Corpus Christi clay has many of the characteristics of the heavy clay soil occupying the valleys of many of the larger streams which traverse the black prairie belt in other sections of the State.

The following table gives the names and areas of the several soil types shown on the accompanying map:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Victoria clay	165,184	71.1	Corpus Christi clay	1,024	0.5
Victoria loam	40,896	17.6	Coastal beach	832	.4
Nueces fine sand	9,920	4.3	Total	232,192	.....
Victoria fine sandy loam	9,536	4.1			
Lomalta clay	4,800	2.0			

LOMALTA CLAY.

The soil of the Lomalta clay, to an average depth of 10 inches, consists of a dark-brown clay or heavy silty clay, which is very stiff and tenacious when wet, but which becomes hard, baked, and sun-cracked and covered with a baked grayish crust when dry. The soil grades into a stiff clay subsoil of light-brown to drab color, which rapidly becomes lighter in color as the depth increases, until at a depth of 30 to 36 inches it is a very light drab, sticky, tenacious clay. At lower depths it often contains small concretions of lime.

This soil is found in the northern part of the area, occupying the low "flats" which occur in the lower valley of the Nueces River and along Nueces Bay. The topography is almost level, but low, shallow basins or swampy depressions which remain wet during the greater part of the year are seen at frequent intervals.

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Most of these flats have only a slight elevation above sea level, and the natural drainage of the whole type is poor. In many localities, especially in the area near the outlet of the Nueces River and in those bordering Nueces Bay, the water table is often encountered within 2 or 3 feet of the surface, and the deeper subsoil remains in such a thoroughly saturated condition that it is soft and plastic.

The soil owes its origin to the deposition of the silt and clay held in suspension by the waters of the Nueces River. The material was first laid down in the shallow waters of Nueces Bay, gradually building up clay flats, which later became covered with a growth of coarse grasses. A large quantity of silt was deposited annually over these salt marshes and they were eventually built up above the level of the salt waters of the bay. Small areas of salt marsh found along the shores of the bay and at the mouth of the river represent the early stages in the formation of this type.

Alkali occurs in both the soil and subsoil of the Lomalta clay, sometimes running as high as 3 per cent. The salts consist chiefly of the chlorides and sulphates of sodium. It will be difficult to free the land of alkali, owing to its low topographical position and poor drainage facilities. Small bodies in the upper part of the area occupied by this type are fairly well drained and are comparatively free from alkali, but they are subject to overflow by the river at times of high water. The alkali found in this soil owes its origin to salt water.

None of the Lomalta clay is at present under cultivation. It supports a growth of coarse grasses and is utilized mainly as pasture land for stock.

The following table gives the results of a mechanical analysis of this soil:

Mechanical analysis of Lomalta clay.

No.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18367	Soil	0.0	0.0	2.1	26.0	21.9	27.9	20.6

NUECES FINE SAND.

The Nueces fine sand consists of 12 to 15 inches of loose, gray, fine-textured sand, often containing enough silt, clay, and organic matter to make it slightly loamy, underlain by a fine sand having about the same texture, but containing less organic matter than the surface soil. The subsoil gradually becomes lighter in color as the depth increases until at about 36 inches it is a very light gray. At this depth it is usually compact and moist. A stiff, slightly mottled, light-drab clay underlies the deposit of fine sand at an average depth of 3 to 5 feet

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below the surface. The surface soil, however, is loose and incoherent, and the depth of the sand deposit varies considerably on account of drifting. A series of low sand dunes has been formed along the northern coast of the peninsula occupied by this soil. Here the sand is much deeper and the soil is at present of no agricultural value. The area covered by these sand dunes is very limited in extent.

The Nueces fine sand is found in one large, unbroken area, occupying the greater part of the small peninsula which lies between the inlet at the mouth of Oso Creek and the Laguna Madre in the southeastern part of the area. One other small area is found bordering an old inlet of Nueces Bay, in the northern part. With the exception of the localities occupied by sand dunes, the surface is comparatively level. Small basins and shallow depressions occur at intervals, and these, together with the low mounds and ridges formed by the drifting sand, give rise to a gently undulating topography. The light, sandy texture of the soil tends to make the natural drainage very thorough, but the heavy clay underlying the subsoil prevents its excessive drainage, and this, together with the loose character of the surface soil, which reduces loss by evaporation, tends to maintain a supply of moisture within the reach of deep-rooting plants.

The deposit of fine sand, from which this soil is derived, was originally deposited along the beaches, but has later been drifted inland by the wind and laid down as a shallow covering over the older formation of heavy clay. Very little cactus or mesquite is found on this soil, but it supports a heavy brushy growth of other native vegetation.

Such a limited acreage of this soil is under cultivation that little is known in regard to its agricultural value. It is easily cultivated, but so loose and incoherent that care must be taken to prevent drifting. Very fair yields of melons and sweet potatoes have been secured, especially when such methods of cultivation were practiced as tended to conserve moisture in the soil. A limited acreage has been planted to cotton, and a yield of about one-half bale per acre secured. Fair yields of early vegetables have also been obtained during favorable seasons. At the present time (1908) the greater proportion of the area occupied by this soil is utilized as pasture land. This land is valued at $25 to $35 an acre.

The following table gives the results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Nueces fine sand.

No.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18371	Soil	0.0	0.3	0.9	80.3	8.5	6.2	4.5
18372	Subsoil	.0	.1	.4	85.5	6.3	7.0	1.5

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VICTORIA CLAY.

The soil of the Victoria clay, to an average depth of 10 inches, consists of a heavy dark-brown to black clay. A small percentage of fine and very fine sand is present in the soil, but the clay content is so great that the surface of the uncultivated areas becomes baked and sun-cracked when dry and very sticky and tenacious when wet. The surface material grades at 10 to 12 inches into a heavy, compact, calcerous clay, which is slightly lighter in color than the surface soil and often contains small concretions of lime. It usually carries less sand than the surface soil and its color gradually becomes lighter as the depth increases, until at 2 to 5 feet it is a light drab to slate gray.

When properly managed this is the most productive soil in the area, but it is not so easily tilled as some of the lighter textured soils. When wet, especially, the soil is very difficult to handle, but when in the proper moisture condition, areas which have already been under cultivation break up into a loamy, friable soil. The hard, baked condition of the surface, however, makes the breaking of new lands extremely arduous. With care the Victoria clay may be kept in a state of thorough cultivation, and profitable yields of almost all the usual crops may be secured without the aid of fertilization. A very large proportion of the entire upland section of the area is occupied by the Victoria clay. The topography of these uplands, while in general almost level, consists of alternating shallow basins and low, gentle swells, giving the type as a whole a very gently undulating surface. In a region of greater rainfall the level character of the plains occupied by this type would result in very poor drainage, but in an area where it is necessary to conserve all of the rainfall possible this feature is an advantage, as the rain water is not carried off rapidly through natural drainage channels, but is slowly absorbed by the soil. Several small arroyos, or wet-weather streams, traverse the plain and serve as an outlet for any excess of water at times of heavy rainfall.

The Victoria clay owes its origin to the weathering of a deposit of calcareous clays which covers the older geological formations to a considerable depth. The clay formation contains a large quantity of lime and when freshly exposed in deep cuts it is much lighter in color than the material found nearer the surface. It weathers rapidly on exposure, forming a dark-brown to black soil.

The Victoria clay, as it is found in this area, is very uniform in texture, color, topographical features, and agricultural value. Small areas, however, occur in some localities, where the surface soil, owing to the presence of a thin coating of sand, is slightly lighter in color than is typical. Along the contact with the Victoria loam or Victoria fine sandy loam a thin coating of sand has been blown over the surface

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from these soils, but there is a small quantity of fine sand everywhere in the soil, and where the surface becomes very dry, the finer particles of silt and clay are carried away by the winds, leaving the thin coating of sand on the surface of the areas found at a distance from the lighter types. The sand causing the grayish appearance of these small areas does not appear to be sufficient to influence the texture of the soil, being only a very thin coating over the heavy clay. Several small shallow basins, where water stands after heavy rainfalls, are found in the western and southwestern parts of the area. The surface of these basins also has a lighter appearance than that of the land surrounding them. This is due to the fine sand and silt which have been washed into the basins from the surrounding areas. The soil becomes thoroughly saturated with water in these basins, and on drying the surface becomes hard, baked, and sun-cracked, causing great difficulty in cultivation. Such areas, however, do not occur frequently and are of very limited extent.

The section of the area occupied by the Victoria clay was formerly an open prairie, supporting a heavy growth of native grasses, but during comparatively recent years the greater proportion of the land has become covered with mesquite, cactus, and other vegetation, greatly decreasing its value as pasture. There are large bodies in the southern and southwestern parts of the area which are not covered by a heavy growth of mesquite, but these usually support a low bushy growth of running mesquite which must be removed before the land can be put under cultivation. As already stated, the extensive root system of this plant makes the clearing of the land much more difficult than appearances indicate.

The Victoria clay is considered the best soil in the area for general farming, and when well cultivated it produces very profitable yields of the various truck crops. It is well adapted to cotton, cabbage, and cucumbers and also gives fair yields of peas, corn, and other crops adapted to the climate. Figs and other fruits are grown only to a very limited extent, but with proper care and attention figs can be grown very successfully on this type of soil. The average yield of cotton in a season of normal rainfall is estimated at three-fourths bale per acre. In favorable seasons a yield of 1 bale to 1½ bales per acre has been secured. Cabbage yields average 12,000 to 15,000 pounds per acre, and a yield of 18,000 to 20,000 pounds may be made in particularly favorable seasons. Cucumbers do well on this soil, the average yield being estimated at 75 to 100 bushels per acre. Onions do fairly well, considering the clayey character of the surface soil, producing an average yield of 7,000 to 8,000 pounds per acre in a favorable season.

The value of the Victoria clay varies from $20 to $150 an acre, according to its location and the extent of improvement.

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The following table gives the results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Victoria clay.

No.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
20324	Soil	0.0	1.0	0.5	8.9	17.6	34.9	37.2
20325	Subsoil	.0	.4	.4	8.2	18.9	30.9	41.2

CORPUS CHRISTI CLAY.

The soil of the Corpus Christi clay is a heavy dark-brown to black clay, with an average depth of 10 to 12 inches. The subsoil, from 12 to 36 inches, is very similar in texture to the surface soil, but contains less organic matter and is slightly lighter in color. Owing to high silt and clay content, this soil is very difficult to cultivate when wet or when it has become baked or sun cracked, but if plowed when in the proper condition it becomes somewhat loamy and friable.

The Corpus Christi clay occurs in the valley of the Nueces River in the northwestern part of the area. The topography is comparatively level, but small, shallow depressions or narrow sloughs which have the appearance of old abandoned stream channels are encountered in the larger areas.

These low valley lands receive the drainage waters from the neighboring uplands and their level topography and slight elevation above the level of the river result in very poor drainage. A large part of the type is subject to overflow during high water.

The Corpus Christi clay is alluvial, having been formed from the silt and clay deposited by the river. These alluvial deposits were laid down in the valley of the river near its outlet into Nueces Bay, but there are no indications to show that this material was primarily laid down in the salt waters of the bay or that the areas were formerly salt marshes similar to those now found near the present outlet of the stream. A small percentage of alkali was found in this soil, consisting chiefly of the chlorides and bicarbonates of sodium. The alkali content, however, is small, usually ranging from 0.20 to 0.50 per cent.

Very little mesquite or cactus is found on this type, but it supports a heavy growth of huisach (*Acacia farnesiana*) and several other species of plants.

Only a very limited acreage of this soil has been put under cultivation and the crops grown have occasionally been destroyed or seriously damaged by the overflow of the river. With these exceptions

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very fair yields of corn have been secured and small areas of cabbage and other garden truck have been successfully grown on the better drained land. The greater proportion of the Corpus Christi clay is utilized as pasture land.

COASTAL BEACH.

Small areas composed of a compact mass of shells and sand cemented with lime occur along Corpus Christi Bay in the northern part of the area and at intervals along the shore of Nueces Bay. These beach deposits, thrown up by the action of the waves, are of slight extent and of no agricultural value. In addition to these areas there is a narrow strip of beach sand occurring along the base of the bluffs which border Corpus Christi Bay, but it is too narrow to be shown on a map of the scale used.

VICTORIA FINE SANDY LOAM.

The soil of the Victoria fine sandy loam is a light-brown to gray fine sandy loam, with an average depth of 12 to 15 inches. This is underlain by a light-drab sandy clay, which is often slightly mottled with iron stains. Thin local deposits of lime are often found scattered through the deeper subsoil. There is a distinct line of contact between the sandy surface soil and the underlying clay, but the upper part of the subsoil contains a larger percentage of sand than that found at a depth of 30 to 36 inches. The depth of the fine sandy loam soil often varies considerably within small areas, owing to the fact that when dry the loose surface material is shifted by the wind, forming small drifts. Small areas of the Victoria fine sandy loam are sometimes encountered, where the underlying clay has a reddish-brown color due to the large quantity of iron it contains. These areas, however, are rare in occurrence and are very limited in extent.

The Victoria fine sandy loam is easily reduced to a state of thorough cultivation, and crops on this type can be given a shallow surface cultivation immediately after rain without danger of forming clods or impairing the physical condition of the soil.

The larger bodies of this soil are found in the northern part of the area, occupying the uplands adjacent to the valley of the Nueces River. An extensive tract also occurs in the northeastern corner, extending in a northwesterly direction from the bluff along Corpus Christi Bay, just south of Corpus Christi, to the bluffs along Nueces Bay northwest of Corpus Christi. Other areas of very limited extent are found at intervals over the comparatively level upland section. The topography of the land bordering the valley of the Nueces River is quite rolling. The hills, however, are low and rounded, with shal-

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low valleys intervening, and the slopes are seldom steep enough to cause serious erosion. The topography farther back from the river valley is less rolling, and the surface of some of the larger tracts is comparatively level or gently undulating. The smaller areas found in the broad, comparatively level plain, occupied mainly by the Victoria clay, usually occur as low mounds or ridges slightly higher than the surrounding land.

The topography and light sandy texture of the Victoria fine sandy loam insures good natural drainage. The heavy clay subsoil aids materially in preventing excessive drainage in the more rolling areas, and the loose fine sand which is constantly shifted over the surface by the wind prevents excessive losses of soil moisture by evaporation, so that crops on this type often suffer less from droughts than those on some of the soils of heavier texture.

The origin of the Victoria fine sandy loam can be traced to the drifting of sand from the old coast line of Nueces Bay to the adjacent areas, giving a shallow sandy veneer to the older formation of calcareous clay. The smaller areas farther back from the ancient coast line probably represent the remains of small sand hills, which have been almost entirely leveled by the winds.

The soil seems well adapted to the growing of early truck crops, but it is necessary to fertilize heavily in order to obtain large yields of onions and cabbage. It is well adapted to tomatoes and also gives yields of lettuce and melons equal to those obtained on any other type in the area. When shallow surface cultivation and other methods which tend to conserve the soil moisture are practiced the yields are always increased. Cotton gives an average yield of about one-half bale per acre where no fertilizer is used. When fertilized and properly cultivated much larger yields are secured. Corn is grown to a limited extent and produces about 20 bushels per acre.

Without fertilization the average yield of onions is estimated at about 5,000 pounds per acre, but where heavily fertilized and carefully cultivated a yield of 10,000 to 12,000 pounds per acre is often secured. Lettuce does exceedingly well and is a very profitable crop. Cowpeas and beans also do well and are also beneficial in keeping the soil in a productive state. Both Irish and sweet potatoes give fair yields. Sweet potatoes seem better adapted to this soil than to the types of heavier texture. Watermelons are grown to a limited extent and give good returns. Tomatoes also yield well and if properly cultivated the crop is seldom a failure.

This land is valued at $25 to $100 an acre, according to its location in the area and the extent of improvements on it.

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The following table gives the average results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Victoria fine sandy loam.

No.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18375, 18377.....	Soil.....	0.1	0.6	2.0	50.1	25.7	16.2	5.7
18376, 18378.....	Subsoil	.2	.8	1.7	34.2	11.0	23.6	27.7

The following sample contained more than one-half of 1 per cent of calcium carbonate ($CaCO_3$): No. 18376, 13.60 per cent.

VICTORIA LOAM.

The Victoria loam consists of 10 or 12 inches of light-brown to dark-gray loam grading into a light-drab to slate-colored clay, which contains a considerable quantity of sand near the contact with the loamy top soil, but becomes heavier and more compact as the depth increases. Small deposits of lime are found scattered through the subsoil.

The surface soil contains enough clay to make it slightly sticky when wet, but there is enough sand present to prevent it from forming into hard clods when cultivated and to give it a loamy friable character. The soil represents the type intermediate between the heavy Victoria clay and the lighter textured Victoria fine sandy loam. When the Victoria loam borders the Victoria fine sandy loam the surface soil contains higher percentages of sand than usual. This is due to the larger percentage of fine sand, which has been deposited along the boundaries of these two soils by the action of the wind. A very thin layer of this fine wind-blown sand is often found on the compact surface of the uncultivated land, giving it a slightly grayish appearance, and small areas, only a few square rods in extent, sometimes are seen where this sandy material has been formed into shallow drifts, giving the soil a slightly lighter texture than that of the typical Victoria loam. On the other hand, where this soil borders the Victoria clay, the loamy surface soil becomes shallower and the clay content gradually increases until it grades into the heavier black clay.

This soil is found in areas containing a few square rods to several square miles, scattered over the upland in almost every part of the survey. The topography is in general almost level, but in detail consists of low elevations and small shallow basins, making the surface of many of the larger areas gently undulating.

The natural drainage of the greater part of the Victoria loam is good, but some of the small shallow basins receive the drainage waters

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from the surrounding land at times of heavy rainfall and remain in a wet condition until the water has evaporated. On drying, the surface of these small basins becomes hard, baked, and sun cracked and usually has a light grayish appearance.

The Victoria loam is formed by a mixture of the fine sandy material composing the lighter fine sandy loam or fine sand with the finer textured material of the heavy clay soil covering the greater part of the upland plains. Some of this fine sand was probably mixed with the heavier clay soil at the time of deposition, but the sand content of the greater proportion of this type has resulted from the action of the wind.

The soil supports a very heavy growth of a great variety of vegetation, principally mesquite and several species of cacti. With the exception of the few small basins mentioned above, where the natural drainage is poor, the land is very productive and is well adapted to truck, as well as to cotton and other general farm crops.

The Victoria loam is considered the best soil in the area for the growing of onions and is also well adapted to cabbage, lettuce, and cucumbers. Very careful cultivation, however, is necessary in order to get the best results on this soil. If deep plowing is practiced and the soil is kept free from weeds and is given a shallow surface cultivation at frequent intervals, a profitable yield is always secured. In seasons of ordinary rainfall the average yield of onions is estimated at 10,000 pounds per acre, and in years having a larger precipitation the yields may reach 12,000 to 15,000 pounds per acre. The average yield of cabbage is about 14,000 pounds per acre, but a yield of 20,000 pounds is not uncommon on areas which have been carefully cultivated. Okra has been grown to a limited extent and very fair yields obtained. Cucumbers do well, but require very careful cultivation, as the crop is liable to be damaged by drought.

Cotton gives an average yield of one-half to three-fourths bale per acre, but when fertilizer is used and the soil is properly cultivated a yield of 1 bale has often been obtained. Corn has been grown to a limited extent and yields on the average from 20 to 30 bushels per acre, with maximum yields of 40 bushels per acre under the most favorable conditions. Cowpeas do well on this type and should be included in the rotation of crops, especially on land which is cultivated throughout the year. Sorghum cane is another of the general farm crops grown successfully. At present only a limited acreage is planted. Two cuttings are usually obtained, and sometimes in a very favorable season three cuttings may be made. With the average rainfall Irish potatoes yield from 60 to 75 bushels per acre. The yield is usually very light in dry seasons. Sweet potatoes are also produced to a limited extent and with ordinary rainfall, when carefully cultivated, the yield is fair.

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The undeveloped land of this type is valued at $20 to $50 an acre, according to distance from the local markets and a shipping point. The areas under cultivation are valued at $50 to $100, depending upon their location and the character of improvements.

The following table gives the average results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Victoria loam.

No.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18355, 18357.....	Soil.....	1.1	4.1	2.5	21.0	16.5	36.1	18.4
18356, 18358.....	Subsoil.....	.0	.5	.8	35.4	18.8	21.3	23.0

The following sample contained more than one-half of 1 per cent of calcium carbonate ($CaCO_3$): No. 18358, 1.18 per cent.

SUMMARY.

The Corpus Christi area is located on the Gulf coast of South Texas and comprises 232,192 acres, or about 363 square miles, in the northeastern part of Nueces County. The greater part of the area is an almost level plain, the remainder, the country bordering the valley of the Nueces River, is generally rolling. The "flats" occupying the river valley are level and poorly drained.

Drainage is effected by the Nueces River and several large intermittent creeks. Although the area is thinly settled at present, the incoming population is considerable and agricultural development is progressing rapidly. The St. Louis, Brownsville and Mexico, the Texas Mexican, and the San Antonio and Aransas Pass railroads furnish good transportation facilities.

Corpus Christi, a town of about 10,000 inhabitants, is the principal town in the area and also the local market for all products.

The climate is very mild in winter and is not extremely warm in summer. The maximum temperature recorded at Corpus Christi during the past nineteen years is 98°. It is very unusual for the temperature to go below 27° or 28° in winter.

For a long while stock raising was the leading industry. In recent years, however, there has been rapid agricultural development, especially in the growing of truck crops.

Seven types of soil were mapped.

The Lomalta clay is an undrained soil in the northern part of the area, occupying low flats in the valley of the Nueces River and along Nueces Bay. None of this type is under cultivation. It supports a growth of coarse grass and is utilized mainly for pasture.

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The Nueces fine sand is for the most part used as pasture land, though a limited acreage is cultivated, giving fair yields of cotton, melons, sweet potatoes, and early vegetables.

The Victoria clay, an upland type, when properly managed is the most productive soil in the area. This land was formerly an open prairie covered with a heavy growth of native grasses, but in recent years the vegetation has consisted largely of mesquite, cactus, etc., which has diminished its value as pasture land. Where cultivated good yields of cotton, cabbage, cucumbers, and onions are secured. If well cultivated various truck crops can be successfully grown. It is valued at $20 to $150 an acre.

The Corpus Christi clay is mainly pasture land, a comparatively small acreage being under cultivation. When not damaged or destroyed by overflows of the river fair yields of corn have been secured, and some garden truck has been grown on the better drained portion of the type.

The Victoria fine sandy loam seems well adapted to early truck crops, such as onions, cabbage, lettuce, melons, tomatoes, and potatoes, and gives fair yields of cotton and corn.

The Victoria loam, found in scattered areas over the upland in almost every part of the survey, is a productive soil. It is adapted to truck as well as to cotton and other general farm crops. It is considered the best soil in the area for the growing of onions. The native vegetation consists largely of mesquite and cactus.

The Coastal beach comprises small areas along Corpus Christi Bay and Nueces Bay. These beach deposits, thrown up by the action of waves, are of no agricultural value.

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SOIL SURVEY OF FRANKLIN COUNTY, TEXAS.

By A. E. KOCHER and W. S. LYMAN.

DESCRIPTION OF THE AREA.

Franklin County lies in the northeastern part of the State of Texas, in the second tier of counties from the Oklahoma line, being separated from Oklahoma by Red River County, and is the fourth county from the Arkansas line. It is bounded on the north by Sulphur River, on the east by Titus and Camp counties, on the south by Wood, and on the west by Hopkins County. It is included between

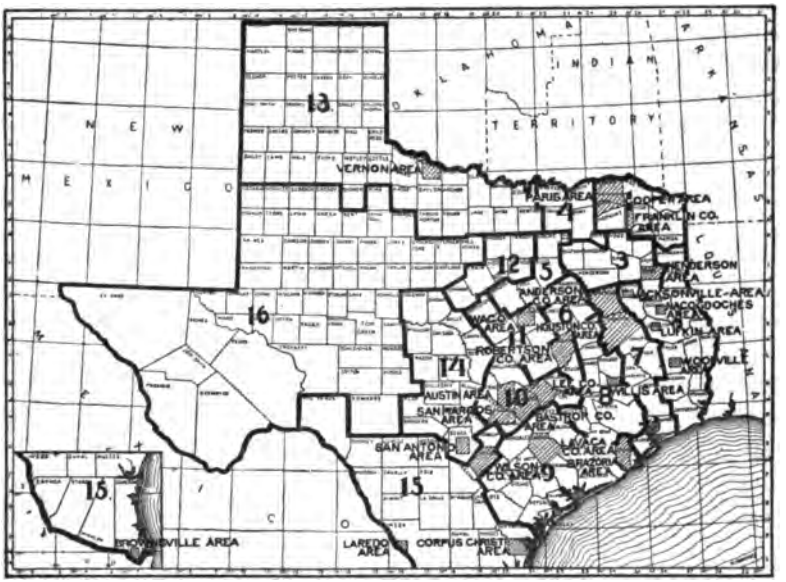

FIG. 24.—Sketch map showing location of the Franklin County area, Texas.

the meridians 95° 6′ 30″ and 95° 16′ west longitude and the parallels 32° 57′ 24″ and 32° 22′ 26″ north latitude. It is one of the smaller counties in the State, containing only 186,944 acres, or about 292 square miles. Geographically the county occupies a position between two natural divisions of the State. To the west occurs the broad treeless region of Central Texas, with its characteristic level or gently rolling topography, while to the east is found the more

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broken eroded district of East Texas. Each of these divisions is represented in the county, but the prairie region, which occurs mainly in the northern part, occupies only about 15 per cent of the total area. Here the topography is quite level, and the few streams flowing through the section have comparatively shallow channels. The drainage is good, the principal stream in this region being the Sulphur River, which bounds the county on the north. This stream has its source in the Grand Prairie belt to the west and for several miles flows through black calcareous clays. During times of flood a large quantity of this fine material has been brought down and deposited over a broad, level flood plain, forming a soil of unusual strength and productivity.

The topography of the southern half of the county is considerably more broken than is that of the northern half, a condition due largely to erosion. In general, however, the surface features of the county are somewhat less broken than is usually the case in other East Texas counties.

By reference to the accompanying map it will be seen that two prominent divides separate the drainage systems of the county. One of these, between Sulphur River and White Oak Creek, passes from east to west across the northern part of the county, including the locations of Hagansport and Lavada. The second and more noticeable divide, separating the drainage systems of White Oak and Cypress creeks, passes through the town of Purley and thence north and east beyond the limits of the county.

The drainage systems of the area are well established, several streams having attained considerable size before entering the county from the west. White Oak Creek, the largest of these, has its source near Sulphur Springs, and after traversing the width of the county enters Sulphur River about 30 miles to the east. Entering White Oak Creek from the south are several lesser streams, of which Big Creek is the most important. This stream, rising in the vicinity of Purley, flows nearly north for about 10 miles, and with its numerous laterals from the east completely drains this part of the county. Beyond the divide to the east and south the county is drained by Cypress and Brushy creeks, the former of which has four important tributaries entering from the north—namely, Panther, Broughams, Andys, and Smiths. Brushy Creek, which forms a part of the east county line, has several important branches entering from the west, among the largest of which is Dry Cypress Creek.

The area now included in the county received its first permanent settlers about the year 1836. These came from Tennessee, and for more than thirty years the immigrants to the county were natives of that State. In 1870 immigration began to come in from Georgia

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and Alabama, and five years later the county was organized. Settlement, however, was slow until 1887, when the completion of the railroad across the county encouraged development. The county is still but sparsely settled. In a total of 118,528 acres included in farms, according to the Twelfth Census, only 59,841 are under cultivation.

Mount Vernon, the county seat, is the largest town in the area. Winnsboro, on the southern line, has a population of about 900 and is an important shipping point for the southern part of the county. Another shipping point is Winfield, which is situated just across the line in Titus County, on the St. Louis Southwestern Railroad. Other small centers in the northern part of the county are Daphne, Lavada, and Hagansport. In this part of the county development is seriously hindered by the absence of adequate shipping facilities. The St. Louis Southwestern Railroad, crossing the central part of the county in an east and west direction, connects the area with St. Louis and the principal cities of the north and with Dallas and Fort Worth on the west. The latter point is an important one because of the active demand for live stock at that place. The Missouri, Kansas and Texas Railroad, touching the southern end of the county near Winnsboro, provides transportation facilities for that place and vicinity.

CLIMATE.

The climate of Franklin County is mild and agreeable. The summers are long, but the heat is usually tempered by the cool breezes from the Gulf.

During the period from 1894 to 1903, according to the records of the Weather Bureau station at Paris, the average number of days on which the temperature exceeded 100° was 17, varying from none in 1895 to 37 in 1899.

The winters as a rule are moderate, but are occasionally marked by sudden falls of temperature, due to "northers," or sudden cold waves from the North. These periods, however, are rarely more than two or three days in length and are not frequent. Plowing can be done during any month of the year and the growing season is such that at least two plantings of most crops can be matured between the opening of spring and the first killing frost of fall.

The following table, compiled from the records of the Weather Bureau station at Paris, gives the normal monthly and annual temperature and precipitation, etc.

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Normal monthly and annual temperature and precipitation, etc.

Month.	Temperature.			Precipitation.			
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year.	Total amount for the wettest year.	Snow, average depth.
	°F.	°F.	°F.	Inches.	Inches.	Inches.	Inches.
January	45	83	8	2.1	3.1	0.4	1.8
February	44	84	−13	2.0	.3	2.2	1.4
March	55	92	18	3.5	.6	4.0	0
April	65	96	29	2.9	3.2	4.7	0
May	71	96	38	4.5	2.4	4.3	0
June	78	104	46	3.3	1.2	2.0	0
July	83	108	60	3.1	1.5	4.6	0
August	82	110	57	2.0	Trace.	.1	0
September	76	106	42	2.8	.6	6.7	0
October	66	95	33	2.3	3.0	3.8	0
November	54	85	18	2.7	.6	11.9	0
December	46	80	5	2.1	1.9	3.4	.5
Year	64	110	−13	33.3	18.4	48.1	3.7

Average date of latest killing frost in spring, March 28, and of the first in fall, November 15.

Date of latest killing frost in spring, April 12, and of earliest in fall, November 3.

From this it will be seen the coldest month is February, and the hottest months are June, July, August, and September, for the last four of which occasional temperatures above 100° are usually recorded.

As a rule the rainfall is ample and well distributed, although dry years occur, when considerable loss is occasioned through insufficient cultivation and failure to conserve soil moisture. The average yearly rainfall at Paris is 33.3 inches, of which 10.9, or nearly one-third, occurs during May, June, and July. The total precipitation for the wettest year is 48.1 inches, and for the driest year 18.4 inches. Of this precipitation 3.1 inches are recorded for the growing months of June, July, and August.

The average date of the last killing frost in the spring is March 28, and of the first in the fall November 15, giving an average growing season of 232 days. The latest recorded date of a killing frost in spring is April 12, and of the earliest in the fall November 3.

AGRICULTURE.

From the settlement of the county in 1836 agriculture has been the dominant industry. Until after the civil war subsistence crops such as wheat, corn, potatoes, and vegetables only were grown. This was due to the fact that the nearest market for salable products was at Jefferson, 65 miles away, and cotton was in very little demand. The

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methods in use during these early years were necessarily crude. No effort was made to cultivate the prairie soils, settlement being mainly on the sandy lands near the edge of the timber belt. The prairies, however, were highly valued as ranges for stock, and for many years the early settlers derived their sole income from this source. At the close of the civil war the methods of agriculture began to change. New settlers came in from Alabama and Georgia and took up the sandy lands in the southern part of the county. At this time cotton was high and in a few years crowded out wheat entirely, notwithstanding the fact that cotton had to be marketed 65 miles away. About 1885 the growing of wheat was again attempted, but the practice soon died out, and in the year 1900, according to the records of the Twelfth Census, only 549 acres were grown, with an average yield of less than 10 bushels per acre. Since this date practically all of the wheat products used in the county have been imported.

In 1887 a great stimulus was given the agriculture of the county by the completion of the St. Louis Southwestern Railroad, by which the county was placed on a direct line with the most important markets of the North. During the next few years settlement was rapid, but for the last decade the increase in population has been slight. A decided improvement, however, has been made in the agricultural methods and conditions. The acreage of trucking crops has been largely increased, and in the vicinity of Winnsboro the peach industry has been widely extended. According to reliable farmers, 80,000 peach trees were planted near this town in 1905, in 1906 there were planted 180,000, and in 1907 150,000 more; so it is safe to estimate that at the present time there are at least a half million trees in this vicinity just coming into bearing. Young orchards are also being put out around Mount Vernon, and the prospects for financial success are encouraging. This activity shows an awakening to the agricultural possibilities of the county as a fruit district, for in 1900, according to the census, the total value of the orchard products was only $9,073. Vegetables have always held a prominent place in the acreage of cultivated crops, their total value in 1900 being $21,796. During the year 1907 it was estimated that 50 carloads of Rockyford cantaloupes were shipped from Winnsboro alone, besides considerable quantities of cabbage, etc. In the same section watermelons are beginning to be grown in a small way and give promise of being a success. The greatest efforts, however, have been devoted to the production of cotton and corn, of which 19,632 and 18,039 acres, respectively, were planted in 1900. From this acreage 7,058 bales of cotton and 318,730 bushels of corn were produced. During this year 2,044 acres of oats were planted, giving on an average a yield of about 20 bushels per acre. Notwithstanding the marked adapta-

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tion of some of the lowland soils to the production of forage crops and grasses, little effort is made to utilize them for this purpose. Only 396 tons of tame grasses were produced in the county in 1900, and since that date this amount has probably not been much increased, although considerable quantities of feed stuffs are annually imported from the West. In 1900 the county produced 108 acres of alfalfa, but the acreage at the present time is probably much less. This condition is due in a large measure to the fact that the soils used were not those best adapted to the plant. The county possesses several soils which if properly drained and protected from standing water would be well adapted to alfalfa. These are the Houston clay, Wabash clay, Sanders clay loam, Wilson clay loam, and Wilson loam. Although the adaptability of the sandy meadow lands to the production of sugar cane is quite generally recognized throughout the county, few fields of more than one-half acre in extent are seen on any farm. As the yield ranges from 250 to 500 gallons of sirup per acre, which sells readily for 35 to 50 cents a gallon, it would seem that a greater effort should be made to produce the crop commercially.

During the last two years considerable attention has been given to the production of peanuts. The sandy soils in the vicinity of Winnsboro and Mount Vernon are well adapted to this crop and return yields of 45 to 95 bushels per acre. The average price of the nuts is about 95 cents per bushel, most of the crop being disposed of at Marshall and Terrell, where mills for the extraction of the oil have recently been located.

The rotation most commonly practiced throughout the county is little suited to the requirements of the soils. Cotton and corn, being the chief crops grown, follow themselves or each other in the rotation year after year. The commendable practice of planting cowpeas in the cornfields at the time of the last cultivation is becoming more common, but is not yet as general as it should be. Ridge cultivation is still employed on some of the soils, but it is being recognized that this method favors the loss of soil moisture and the practice is gradually giving way to level culture. Cotton seed has been used as a fertilizer for several years, but the use of commercial fertilizers dates back only a few years, as is shown by the fact that according to the Twelfth Census only $124 was expended for this purpose in 1900. Since then the county's expenditure for fertilizer has increased several thousand dollars.

As a rule the labor used throughout the county is cheap, but the efficiency is usually rather low. The average wage for day laborers is about 50 cents a day or from $10 to $15 per month and board. Although a few large tracts of land are held by individuals as forest, or for grazing, the average size of farms in the county is relatively small, being in 1900 only 77.9 acres. During that year the percentage of

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farms operated by the owners was 44.1, but since that date many of the tenants have acquired title to lands and now operate their own farms. The rental paid is on the usual share plan, by which the tenant furnishes everything but the land and buildings and receives one-half the crops. When the tenant furnishes only the labor he is given one-third of the corn and one-fourth of the cotton. Until the development of the trucking industries within the last few years the value of lands in the county was very low. Most of the land can still be bought for $5 to $10 an acre, but in the vicinity of Mount Vernon, near Winnsboro, and in the heavy bottoms of Sulphur River, the value ranges from $15 to $30 an acre.

As is common throughout the most of the South, the greatest hindrance to the agricultural development is the continuance of the one-crop system. Cotton and corn are the chief crops grown, but a greater effort should be made to introduce a more diversified system which will include the growing of live stock, fruits, vegetables, and truck. While a few small herds of cattle are being grazed on the prairies, the number that is still being kept in the county is far below that which should be produced. Not only should a greater number of animals be kept, but there is an urgent need for the introduction of improved breeds of stock, and to this end it is imperative that the production of grasses and feed stuffs be first given additional attention.

SOILS.

From the standpoint of formation the soils of Franklin County fall naturally into two general divisions—the upland or sedimentary soils and the lowland or alluvial soils. The upland soils may again be broadly divided into seven general groups or series, while those of the lowlands, exclusive of Meadow, fall naturally into two. The upland series are what is known as the Susquehanna, Norfolk, Lufkin, Wilson, Caddo, and Orangeburg, all of which have been previously mapped in other Texas areas. The first four of these series are general in occurrence and are represented in the county by two or three types each, while the others are of limited extent and represented by but one type each.

Geologically the county occupies an intermediate position between the Eocene sands of the East Texas timber belt and the heavier Cretaceous deposits of the Grand Prairie region. About four-fifths of the county is occupied by the East Texas sands, from which are derived 11 of the 15 upland soils. West of these sands a narrow strip extends southward to the Colorado River and beyond, paralleling the eastern border of the Cretaceous prairie belt. This strip, which forms the northern part of Franklin County, is mainly level prairie, dotted here and there with small groves of scrub oak and

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hickory. The soil materials consist chiefly of brown fine sands, overlying stiff laminated clays. These "basal clays," so called from their position as the lowermost beds of the Eocene, are usually gray or brown in color and in their lower depths are almost always stratified.

The lowlands, exclusive of Meadow, are made up, first, of the Sanders soils, or gray silt loams and clays of the central and southern parts of the county found along White Oak, Cypress, and Brushy creeks, and, second, of the Wabash or black, heavy soils brought down from the Grand Prairie region and deposited along the Sulphur River bottoms. These soils during various seasons of the year are all more or less subject to overflow and in their present condition are of relatively low agricultural value. The Wabash clay, however, is an exceptionally strong soil and if drained and protected from overflows would be one of the most valuable in the county.

The most widely distributed soil in the county is the Susquehanna fine sandy loam. This is practically identical with the type of the same name found in other East Texas areas.

Only a very little typical Norfolk fine sandy loam is found in Franklin County. The type is usually closely associated with one of the soils of the Susquehanna or a phase of the Caddo fine sandy loam and in places has points in common with each of these types.

The following table gives the names and areas of the several soil types, while the accompanying map shows their distribution over the county:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Susquehanna fine sandy loam	77,952	41.7	Wilson clay loam	3,200	1.7
Lufkin fine sandy loam	22,848	12.2	Lufkin silt loam	2,176	1.2
Norfolk fine sand	18,560	9.9	Sanders clay loam	1,664	.9
Wilson loam	14,848	7.9	Orangeburg sand	1,280	.7
Meadow	12,480	6.7	Houston clay	832	.5
Caddo fine sandy loam	9,408	5.0	Lufkin fine sand	832	.5
Wabash clay	6,336	3.4	Susquehanna clay	448	.3
Norfolk fine sandy loam	5,312	2.8	Total	186,944	.....
Sanders clay	4,928	2.6			
Sanders silt loam	3,840	2.0			

LUFKIN FINE SAND.

The soil of the Lufkin fine sand from 6 to 20 inches is a gray or brown fine sand overlying material of similar texture but of a somewhat lighter color. At 2 to 4 feet deep occurs a gray or mottled yellow and gray compact clay, which in the lower depths is usually stratified. The soil has a loose, porous structure and is easily worked.

On account of its limited extent, the type is of very little agricultural importance. Only three small bodies were seen in the northern

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part of the county, the largest of which is situated about 1 mile northeast of Hagansport. Here it occupies a position 20 to 30 feet below the level of the adjacent prairie to the south and 10 to 15 feet above the Sulphur River bottoms. The topography of this body is that of low swells and hollows with a difference in elevation of 3 to 5 feet. In the northwest corner of the county the type is found at the base of low hills and occupies a gentle, uniform slope. The surface drainage is therefore good. Its formation is due in this instance to the deposition above the stratified clays of sandy materials washed from the higher lying Susquehanna soils.

About 75 per cent of this type was orginally covered with oaks and hickory, about one-half of which has been removed. The remainder of the type is prairie, much of which is still covered by the native wild grasses.

Where the type is properly drained it is early and adapted to a wide range of cultivated crops. The nearest market, however, is 12 to 16 miles away, so that little opportunity for the shipment of crops is given. Only a few acres of the type are under cultivation, these being devoted to cotton and corn. The yield of the former is from one-fifth to one-half bale per acre, with an average of about one-third bale. Corn yields on an average about 15 bushels per acre. The land is valued at $4 to $7 an acre.

The following table gives the results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Lufkin fine sand.

No.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18325	Soil	0.2	0.4	0.3	11.7	21.4	59.4	6.6
18326	Subsoil	.3	.5	.3	12.9	26.9	49.0	9.9

LUFKIN FINE SANDY LOAM.

The soil of the Lufkin fine sandy loam is a dark-gray or brown rather silty fine sand or fine sandy loam from 8 to 20 inches deep, with an average depth of about 1 foot. The subsoil is an impervious brown or gray stratified clay, the stratification becoming more pronounced as the depth increases. When dry, the soil is loose and friable and easily cultivated, but when wet becomes compact and cohesive, in which condition it is difficult to handle.

The type is found only in the northern half of the county and is confined mainly to the prairie region, which extends in two continuous strips in an east and west direction across the county. One of the largest and most important bodies is found just north of Mount Ver-

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non, whence it extends eastward along White Oak Creek beyond the county limits. Another body occurs to the south of Sulphur River and includes Hagansport and Lavada.

In the northeastern part of the county a characteristic feature of the type is the presence of small mounds from 2 to 4 feet high and from 20 to 40 feet across. On these the material is a fine gray sand 3 feet or more in depth. These mounds are comparatively few in number and their aggregate area is very small.

In the eroded section the type differs somewhat from that occurring on the prairie in that the surface is nearly always a gray fine sand or fine sandy loam, the lighter color being due to the smaller quantity of organic matter incorporated with the soil. The subsoil is also lighter colored, consisting usually of gray or drab stratified clay. The principal bodies of this phase were found southwest of Hagansport and as narrow strips along the north side of White Oak Creek.

Except for a few gently rolling areas, the topography of the type is uniformly level and drainage frequently inadequate. This is especially true where the flat areas are of considerable extent for the heavy, impervious subsoil prevents the downward passage of water and the only means of removal is by evaporation.

The Lufkin fine sandy loam is a sedimentary soil derived from the weathering of old marine beds. As the soil occupies a position between the "Grand Prairie" region on the west and the East Texas timber belt, it is probable that, like the Wilson loam, it has been influenced in its formation by both the Upper Cretaceous and the lower Eocene.

About 10 per cent of the soil found in Franklin County was originally treeless and covered by a valuable growth of native prairie grass. The remainder is covered chiefly with post oak, but some red oak, blackjack, and hickory are also found.

The Lufkin fine sandy loam if well drained is adapted to the production of apples, peaches, pears, small fruits, and truck. Cotton and corn are the chief crops, the yield of the former under the same conditions being slightly better than that of the latter. Cotton yields from one-third to one-half bale and corn from 15 to 20 bushels per acre. In the northwestern part of the county a large part of this type is still used for grazing and the production of wild hay. Where cultivated, ridge cultivation is practiced and the plowing is very shallow.

The greatest needs of the soil are more thorough cultivation and a diversification of crops and a deeper plowing of the soil. The land is held at $5 to $15 an acre, depending on improvements and location.

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The following table gives the average results of the mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Lufkin fine sandy loam.

No.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18056, 18327.....	Soil.....	0.7	1.2	0.3	28.2	15.9	48.7	6.7
18057, 18328.....	Subsoil.....	.2	.4	.3	19.6	11.9	43.9	23.2

LUFKIN SILT LOAM.

The soil of the Lufkin silt loam to a depth of 4 to 8 inches is a gray silt loam or silty fine sand with an average depth of about 6 inches. The subsoil is an impervious gray or mottled yellow and gray silty clay, which in the lower depths becomes distinctly stratified. In a few places limited bodies are covered with 1 to 3 inches of sharp, fine sand. These usually occupy slightly depressed positions adjoining bodies from which the surface material has been largely removed, in which case the underlying clay is covered by only a very thin layer of gray silty loam. On a part of the type small mounds of sand are found and near these the soil is a heavy fine sandy loam.

The type is of limited extent, occurring only in a few small bodies in the northwestern part of the county. The surface is flat and after heavy rains is more or less covered with water.

Over much of the type both the soil and subsoil are similar to the soil and subsoil of the Lufkin clay found in other East Texas areas, but owing to the depth of the silt loam covering the type has been classified here as Lufkin silt loam.

Because of poor drainage only a few acres of this soil are under cultivation, the rest being occupied by valuable forests of post oak with some red oak and hickory.

When well-drained, fair yields of the staple crops are secured, but the type at best is only moderately productive. The soil is well adapted to the growth of redtop, or herd's-grass (*Agrostis alba*), and if this plant is once established there is no doubt that it will prove of value either as a hay crop or as permanent pasture sod. In preparing for the seed the ground should be thoroughly pulverized, and if possible should receive a dressing of manure before the plowing is begun. The value of the Lufkin silt loam averages about $5 an acre.

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The following table gives the results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Lufkin silt loam.

No.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18323	Soil	0.1	0.3	0.2	12.0	24.5	50.2	12.0
18324	Subsoil	.0	.1	.2	8.7	20.5	42.6	27.1

SUSQUEHANNA FINE SANDY LOAM.

The soil of the typical Susquehanna fine sandy loam to a depth of 4 to 10 inches is a gray fine sand resting on a light fine sandy loam of a yellowish gray color. At an average depth of about 12 inches a red or mottled yellow and red stiff waxy clay appears, which continues to a depth of 2 to 3 feet. Below this depth the subsoil is rarely uniform in color, but varies from mottled, waxy clay to heavy gray material, which bakes and cracks into cubical blocks on exposure to the sun.

The structure of the soil is loose and porous and cultivation is easy. On some of the higher elevations where the drainage is good the soil has the appearance of the Orangeburg fine sandy loam found in other east Texas areas. The surface 8 or 10 inches is a red fine sandy loam thickly strewn with iron sandstone gravel. The subsoil, however, unlike that of the Orangeburg type, is a heavy, red plastic clay.

The typical soil most commonly occurs in irregular discontinuous strips on the slopes of drainage ways, the largest areas lying on each side of White Oak Creek and in the vicinity of Mount Vernon, Purley, and Macon. The topography varies from fairly level to rolling or hilly. On the slopes drainage is usually adequate for agricultural purposes, but the compact structure of the impervious clay subsoil is such that the downward passage of water is very slow and where the soil is even moderately level the drainage is poor. In such areas the soil would be benefited by artificial drainage.

The typical Susquehanna fine sandy loam owes its formation largely to the weathering of marine beds of sandy clay, but it is probable that as the Eocene age advanced a thin stratum of sandy material was deposited above the more finely divided clays.

Notwithstanding this soil has the greatest cultivated acreage in the county, there is still a large percentage of it in its natural wooded state. The growth consists of red oak, post oak, black-jack oak, and hickory. Only rarely are pines found on this type.

This soil is only moderately productive, but responds readily to fertilization and intensive cultivation. For this reason it is adapted

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to a wide range of cultivated crops. Peaches have been found to do well, but the soil is not considered quite so desirable for this fruit as some of the sandy types of the Orangeburg series. Apples and pears have been grown to some extent and have given satisfactory returns. It would seem that the acreage of the fruits could well be enlarged. The soil is also adapted to Irish potatoes, sweet potatoes, peanuts, cowpeas, and truck. Radishes should do well and where markets are easily reached should be a profitable crop. About 90 per cent of the area under cultivation is devoted to cotton and corn. Cotton yields from one-fourth to one-half bale per acre and corn from 12 to 20 bushels. When commercial fertilizers are used for cotton, a brand containing about 2.05 per cent of nitrogen, 8 per cent of phosphoric acid, and 1 per cent of potash is bought. From 200 to 400 pounds of this mixture are applied per acre.

There is a phase of the Susquehanna fine sandy loam which differs from the typical areas mainly in the greater depth of the surface material. The soil is a loose gray sand or light sandy loam of fine to medium texture with an average depth of about 2 feet. The depth, however, varies greatly, ranging from 15 inches to 3 feet. The subsoil is a red, waxy, impervious clay resting on a gray or mottled red and gray clay from 2 to 3 feet deep. In the lower depths the clay is almost gray, especially in the lower areas, where drainage is deficient. On account of the greater depth of the loose surface soil this phase is considered more easily cultivated than is much of the typical soil.

The deep phase of the Susquehanna fine sandy loam occurs in many small bodies widely distributed throughout the county, the most numerous of which are found in the vicinity of Mount Vernon. Its topographic features range from high level plateaus to gentle slopes. On the sloping areas the drainage is good, but the impervious subsoil retains the water on the level areas, making artificial drainage desirable.

The native vegetation consists of red oak, post oak, and hickory. On account of the ability of the heavy subsoil to retain moisture the soil rarely suffers from drought. For this reason it is well adapted to a wide variety of crops. Fruits do well, especially peaches, although few orchards of commercial size are now in bearing. Grapes have been grown to a small extent, and it would seem that the extension of the acreage could be profitably undertaken. The soil is also well adapted to the production of truck, as well as berries and small fruits. Cotton and corn are the chief crops, the yields being about the same as on the typical or main areas of the type.

Although ridge cultivation is still practiced to a great extent, it is slowly giving place to level breaking, a method which favors the retention of soil moisture during the growing season. The plowing,

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however, is much too shallow and better results would be obtained if the ground were broken deeper in the spring and more frequent shallow cultivation given during the summer months.

The fertilizer most commonly used on this deep phase is cotton seed, from 10 to 30 bushels being applied per acre. This is applied chiefly to the cotton crop, little fertilizer being used for corn. When commercial fertilizer is used, from 200 to 400 pounds are applied.

The Susquehanna fine sandy loam is the most extensive soil type in Franklin County, although it occurs in no section in large continuous bodies. The value ranges from $7 to $15 an acre.

The following table gives the results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Susquehanna fine sandy loam.

No.	Description.	Organic matter.	Fine gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0 mm.
	Typical phase:	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
18339.....	Soil.....	.....	0.8	2.0	0.8	9.0	43.0	39.2	5.1
18340.....	Subsoil.....	.....	.0	.3	.3	1.7	8.3	36.1	52.8
	Deep phase:								
18337.....	Soil.....	.....	.1	.2	.4	60.3	10.1	26.5	3.1
18338.....	Subsoil.....	.....	.2	.2	.1	36.7	20.0	17.5	26.2

SUSQUEHANNA CLAY.

The soil of the Susquehanna clay, to about 4 inches in depth, is a grayish-yellow fine sand or fine sandy loam. The subsoil is a red, sticky clay resting on a mottled red and gray sticky clay at an average depth of about 2 feet. When wet, this is very plastic and adhesive and a very refractory soil to work. Only three small bodies of the type were found in the county, the largest of which occurs about 1½ miles east of Majors.

The topography is level, and the surface drainage is fairly good. The soil is sedimentary in origin and was probably formed in the same manner as the Susquehanna fine sandy loam, except that in this case the coarse surface material has been more completely removed, leaving the heavy clay with a shallower covering.

The natural growth is post oak, hickory, and pine. What little of the type is under cultivation is devoted to cotton and corn, the yields of the former ranging from one-fourth to one-third bale and of the latter from 12 to 20 bushels per acre.

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The soil is deficient in organic matter and is in need of the leguminous crops such as cowpeas, vetch, or lespedeza. These should be plowed under in the fall. The value of the land ranges from $4 to $6 an acre.

HOUSTON CLAY.

The soil of the Houston clay is a brown or yellowish-brown clay loam or clay with an average depth of about 4 inches. The subsoil is a brownish-yellow clay from 4 to 20 inches deep, below which the material is sometimes slightly mottled with gray. Where the soil is typically developed, yellowish-brown limestone fragments are found scattered on the surface and embedded in both soil and subsoil.

If cultivated when the content of moisture is favorable the type is not hard to work, but when wet the soil is sticky and plastic, and when dry becomes hard and compact.

The Houston clay is a soil of limited extent in Franklin County, being found only in two small bodies. The most typical of these occurs as a narrow strip immediately south of White Oak Creek bottoms. The other is found occupying a similar position in the northern part of the county south of Sulphur River.

The topography of the type varies from level to gently rolling, the strip south of White Oak Creek occupying the slope separating the prairie from the lowlands. The surface drainage is good.

The Houston clay in Franklin County is largely a residual soil derived from the weathering of calcareous deposits. The areas are treeless and were originally covered by native prairie grass. It is one of the best alfalfa soils in the county and with the present local demand for feed stuffs, this crop should prove one of the most remunerative that could be produced. The type is also adapted to Melilotus, which can not only be used for grazing but which is especially beneficial in its effects upon the land. Unless the soil has been cropped to cotton and corn for several years, it is well adapted to the production of these crops. Cotton yields from one-third to three-fourths of a bale per acre with an average of about one-half bale. The average yield of corn is about 25 bushels per acre.

Notwithstanding the excellent surface drainage of the type, the soil is given ridge cultivation with the result that early in the summer the soil dries out and crops suffer from drought. To lessen this trouble the land should be broken level and given frequent summer cultivations. With the exception of a small quantity of cotton seed applied to the cotton fields, very little fertilizer is used. For general farm crops this is one of the best soils in the county. The value ranges from $10 to $15 an acre.

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The following table gives the results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Houston clay.

No.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18321	Soil	0.0	1.8	1.4	5.0	6.0	57.9	27.5
18322	Subsoil	.0	1.2	.5	1.5	3.4	49.0	43.5

NORFOLK FINE SAND.

The soil of the Norfolk fine sand, to a depth of about 6 inches, is a fine gray sand resting on gray or yellowish-gray fine sand 3 feet or more in depth. In its original state the first few inches is usually a little more loamy than the underlying sand, due to the slight accumulation of vegetable mold. With cultivation, however, this condition soon disappears and the plowed fields present a uniform gray appearance. The structure is very loose and porous, rendering it the most easily cultivated soil in the area.

This soil, which is not extensive, is confined to the southern half of the county, the largest areas occurring near Purley, south of Majors, and in the vicinity of Winnsboro. In some localities the texture of the soil varies considerably, being composed in places chiefly of fine sand and in others containing relatively large quantities of medium sand. The areas of medium sand, however, are all of small extent and so do not appear upon the map as a separate type. The most numerous bodies of medium sand occur scattered through the type in the southwest corner of the county to the north of Broughams Creek and in the vicinity of Majors.

The Norfolk fine sand is most commonly found on broad, plateau-like eminences and has, therefore, a fairly level topography. Few streams are found, but the open structure of the soil provides a ready avenue for the downward passage of water.

The Norfolk fine sand is a sedimentary soil formed by the weathering of marine beds of Eocene age.

In its native state the soil is covered by a growth of pine, sand jack, black-jack, post oak, and hickory.

On account of the rapidity with which the soil dries off in spring, the fields can frequently be plowed while other soils are still too wet for cultivation. This makes it one of the earliest soils in the county and especially adapts it to the production of early truck crops. Tomatoes, peanuts, cowpeas, and sweet potatoes should all do well, and in many cases their cultivation would undoubtedly prove more

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profitable than cotton and corn. The type is also adapted to strawberries, raspberries, and other small fruits, though but little attention is given to their production. In the southern part of the county the Norfolk fine sand is used to a considerable extent for the production of peaches. Near Winnsboro several large orchards were seen which are just beginning to bear and in favorable years are returning their owners a handsome profit. The trees, however, on this type are of comparatively short life. Cantaloupes are also extensively grown and are proving to be a valuable crop.

The greatest acreage of the type is devoted to cotton and corn, the yields ranging from one-fourth to one-half bale and from 15 to 18 bushels per acre, respectively. Peanuts are also beginning to be grown to some extent, the yields ranging from 45 to 75 bushels per acre.

The chief need of the Norfolk fine sand is organic material, which in many of the fields has become noticeably deficient. This condition could best be remedied by the growing of green crops for pasturage during the winter months, to be turned under in the spring before the planting of the usual crops, or as catch crops after corn or cotton. For this purpose vetch is the best crop for winter and cowpeas for summer planting. Clover and peanuts might also be valuable.

About one-third of the Norfolk fine sand in Franklin County is cleared and under cultivation. The value ranges from $5 to $8 per acre for the wooded sections and from $7 to $30 per acre for the cultivated areas, the latter depending on the nearness to market and the state of improvements.

The following table gives the results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Norfolk fine sand.

No.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18329	Soil	0.0	0.2	0.2	77.5	10.4	9.2	3.1
18330	Subsoil	.0	.0	.8	76.2	7.0	9.5	7.2

NORFOLK FINE SANDY LOAM.

The soil of the Norfolk fine sandy loam from 10 to 18 inches in depth consists of a gray or yellowish-gray fine sand or fine sandy loam with an average depth of about 1 foot. The subsoil is a yellow or slightly mottled red and yellow sandy clay which grades into a mottled gray and yellow clay at 3 feet or more.

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Where the soil has not been brought under cultivation the first few inches are usually of a light-brown color, due to the slight accumulation of humus in the surface. The humus, however, disappears after the first few years of cropping. Only very few small areas of the Norfolk fine sandy loam are found in Franklin County. These occur chiefly in the eastern and southeastern parts and occupy low, poorly drained positions around the heads of steams.

The origin of the type is sedimentary, but since its original deposition the surface material has been somewhat modified by an admixture of sands washed down from higher soils. Because of poor drainage the type is cold and late in spring, and in its present condition is not so well adapted to early truck crops as is the Norfolk fine sand. When drained and given thorough cultivation, it is a productive soil, easily worked, and rarely suffers from drought.

On the higher slopes it is well adapted to the growth of late truck, berries, and small fruits. Only a very small proportion of the soil is under cultivation, cotton and corn being the only crops grown. Cotton yields one-fourth to one-third bale and corn from 12 to 20 bushels per acre. On the poorly drained, uncultivated areas Bermuda grass thrives well and provides excellent pasturage. As the type is low in humus, it would be much improved by the turning under of green manures. For this purpose leguminous crops should be used, cowpeas, vetch, and the clovers being the most desirable. The land is valued at $5 to $7 an acre.

The following table gives the results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Norfolk fine sandy loam.

No.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18333	Soil	0.0	0.3	0.2	45.7	25.9	22.4	6.0
18334	Subsoil	.1	.3	.1	43.2	17.4	16.4	21.9

ORANGEBURG SAND.

The soil of the Orangeburg sand consists of a light-gray to reddish-gray sand of fine to medium texture. In depth the soil averages about 20 inches, but varies from 15 to 30 inches, being more shallow on the hillsides, where slight erosion has taken place. The subsoil is a red sandy clay, the sand content being of a fine grade. This sandy characteristic of the subsoil, peculiar to the types of the Orangeburg series, gives it a water-holding capacity and a drought-resisting power above that of the close-structured Susquehanna soils.

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The Orangeburg sand is of very limited extent in Franklin County, aggregating only about 3 square miles. The largest area is found about 6 miles southeast of Mount Vernon. Other small bodies are found near the south county line on the Missouri, Kansas and Texas Railroad in the vicinity of Scroggins and Musgrove. The type of soil as found in the southern part of the county is considerably finer in texture than that found in the northern part. The topography is somewhat hilly, the body southeast of Mount Vernon occupying the highest elevation in the county. This position, together with the peculiar structure of the subsoil, insures both surface and underdrainage.

The soil is formed by the weathering of the Lafayette clays and is the only representative of this formation in the county. About three-fourths of it is forested with oaks and hickory, the remainder being under cultivation. The soil retains moisture well and usually suffers less from drought than the other sandy soils of the area. For this reason, where shipping facilities are at hand, it is well adapted to the production of early truck. Judging from the success attending the cultivation of peaches, tomatoes, radishes, etc., on this soil in other east Texas areas it would seem that these crops could be produced at a good profit in Franklin County. Cotton and corn are the main crops, the yields ranging from one-third to one-half bale and from 18 to 25 bushels per acre, respectively. The value of land of this type ranges from $7 to $10 an acre.

The following table gives the results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Orangeburg sand.

No.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18335	Soil	0.0	5.2	35.3	31.5	9.6	13.7	4.3
18336	Subsoil	.0	6.0	28.5	15.0	5.5	13.8	30.4

SANDERS CLAY LOAM.

The Sanders clay loam consists of about 12 inches of dark-brown clay loam resting on a gray or slightly yellow and gray silty clay. The soil contains a large amount of organic material and is usually loose and porous.

The type is of limited extent in Franklin County, only one small body being found about 4 miles north of Mount Vernon. This occurs as a narrow depression at the edge of the White Oak Creek bottoms. In its lowest part the soil is poorly drained and at rare intervals is

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subject to overflow. Its formation is due in part to flood action and in part to the wash from the adjacent prairie soils.

Originally the type supported a valuable growth of white oak and gum, but most of this has been removed. For cotton and corn this is one of the most productive soils now under cultivation in the county. It is also a good grass land, and, if properly drained, should be adapted to alfalfa. At present the only crops produced are cotton and corn. The former yields from one-half to 1 bale per acre and the latter from 20 to 35 bushels, although as high as 50 bushels per acre have been secured. The value ranges from $10 to $15 per acre.

WABASH CLAY.

The soil of the Wabash clay is usually a dark-brown to jet black heavy, waxy clay with an average depth of about 12 inches. The subsoil, from 12 to 24 inches, varies from black to slightly mottled yellow and brown clay resting on a mottled brown, gray, and yellow material of the same texture. Small lime concretions are occasionally seen scattered over the surface, but aside from these very little grit is found in either soil or subsoil.

This is the heaviest soil in the county, and when wet is so sticky and tenacious that travel on the type is almost impossible. In dry weather the surface bakes and cracks so that the soil is very hard to cultivate except when in the proper moisture condition.

Only one body of Wabash clay is found in Franklin County. This occurs as a strip from 1 to 1½ miles wide in the Sulphur River bottoms which continues across the north end of the county. The soil is subject to frequent overflow and as the surface is level much of it is covered with water for several days at a time. These overflows usually come in the winter and early spring, but are sometimes seen as late as July. Very little of the soil has ever been cleared, most of it being covered by a valuable growth of white oak, sycamore, gum, hickory, and pecan.

The Wabash clay is an exceptionally strong soil, and if protected from floods would be the most productive in the county. The type is a splendid grass land and is well adapted to the staple crops of the area. If well drained, it would also be suited to alfalfa. At present none of the land is under cultivation, though it furnishes considerable pasturage.

The greatest need of this soil is protection from overflows. This could best be accomplished by straightening and cleaning out the channel of the Sulphur River. While this would entail considerable expense the cost would not be out of proportion to the resulting increased value of the lands. Much improvement in the present condi-

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tion could also be cheaply made by deepening some of the numerous bayous which wind through the bottoms.

Although this land is situated 12 to 18 miles from market, it is held as high as any land in the county. Its value ranges from $15 to $30 an acre.

The following table gives the results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Wabash clay.

No.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18343	Soil	0.0	4.4	1.7	7.0	3.8	46.6	37.2
18344	Subsoil	.0	.6	.4	3.6	5.0	37.7	53.2

WILSON LOAM.

The soil of the Wilson loam, about 6 inches in depth, is a heavy, brown loam marked to a slight extent with reddish-yellow. The subsoil is a yellowish-brown clay from 6 inches to 3 or 4 feet deep, below which occurs a stratum of gray, stratified clay many feet in thickness.

On account of the high organic matter content the soil, if in the proper moisture condition, is loose and mellow and cultivation is easy, but if an attempt is made to cultivate the land when wet the compact and sticky soil material adheres to the plow or comes up in great clods, making a satisfactory tilth difficult to secure.

The Wilson loam is of comparatively small extent, the type occurring only in the treeless part of the county. One of the largest bodies is found on the prairie immediately northwest of Mount Vernon, and others to the south of White Oak Creek and in the vicinity of Hagansport.

Except on the level prairie in the vicinity of Mount Vernon the topography is gently rolling. The surface drainage, therefore, is usually good, but on account of the impervious subsoil adequate underdrainage can be had only by the use of artificial drains.

The type is composed of weathered sea deposits and represents a gradual merging of the stratified Cretaceous clays with the lowermost deposits of the Eocene Tertiary. Except for the occasional occurrence of small groves of stunted oaks, the soil in its native state is covered only by a growth of prairie grass. This is one of the heaviest upland soils in the county and when properly cultivated is well adapted to the growing of general farm crops. It is also well suited to various grasses, and it is probable that on the better

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drained areas alfalfa would do well. The only cultivated crops grown on the type are cotton and corn, which yield from one-fourth to one-half bale and from 15 to 20 bushels per acre, respectively. Cotton is said to give somewhat better yields than corn, and for this reason a much larger acreage is devoted to it.

Owing to the stiff nature of the subsoil, spring plowing is very shallow, the operation consisting of little more than throwing up the surface soil into ridges. During the summer the land suffers badly from drought. This could be largely overcome by deeper plowing and more frequent summer cultivations. The fertilizer most commonly used is cotton seed, of which about 1,000 pounds per acre is usually applied.

The value of land composed of this type of soil ranges from $7 to $15 an acre.

The following table gives the results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Wilson loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18054	Soil	0.4	1.3	0.4	5.7	9.7	63.6	18.3
18055	Subsoil	.0	1.2	.4	5.2	6.2	61.9	25.3

WILSON CLAY LOAM.

The Wilson clay loam consists of 6 to 8 inches of yellowish-brown to dark-brown loam or clay loam, often containing a large percentage of silt, underlain by a yellowish-brown to black clay. When wet the soil is sticky and plastic, which prevents cultivation for several days after heavy rains. Small areas thickly strewn with waterworn gravel are common throughout the type, and limestone concretions are occasionally found in both soil and subsoil.

The Wilson clay loam is found only in a few small bodies in the northern part of the county, the most typical of which occur in the vicinity of Hagansport and Lavada. Other bodies are found about 3½ miles north of Mount Vernon and in the northeast corner of the county.

The topography is gently rolling and the surface drainage is good. Subdrainage, however, is needed in some cases, especially in the comparatively level area near Mount Vernon.

The type is of marine origin and possesses points in common with both the Houston clay and Wilson loam. No trees are found, the wild

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grasses common to all the prairies being the only native vegetation found on this soil. Tame grasses should do well and if the ground is carefully prepared it is probable that alfalfa would succeed. This is especially true of some of the well-drained ridges in the vicinity of Hagansport and Lavada. Unless thoroughly cultivated the soil dries out and suffers from drought during the growing season, and for this reason is somewhat better adapted to cotton than to corn. Excepting about one-half of the body in the vicinity of Lavada which is used for pasturage, nearly all of the Wilson clay loam is under cultivation. Cotton is the chief crop grown, the yield being from one-third to three-fourths bale per acre. The soil is in need of deeper plowing and more frequent summer cultivations, by which means the tendency to suffer from drought may be largely overcome. Land of this soil type may be purchased for $7 to $15 an acre, depending on location, improvements, and state of cultivation.

CADDO FINE SANDY LOAM.

The Caddo fine sandy loam consists of from 6 to 12 inches of gray, or yellowish-gray, fine sand or fine sandy loam, underlain by gray fine silty sand which extends to 30 inches. Below this depth the material is a sticky yellow clay containing varying quantities of sharp fine sand. In areas where drainage is poor the deep subsoil is sometimes a compact or mottled gray and yellow clay. As a rule, the gray color increases with depth, the deep subsoil commonly being a sticky gray clay.

The Caddo fine sandy loam is found chiefly in the central part of the county, the largest and most numerous bodies occurring in the vicinity of Mount Vernon and others from 10 to 40 acres in extent are found farther east. The elevation of most of the type is somewhat lower than that of the adjacent soils and the topography is usually quite level. Because of the low, flat, or depressed surface configuration, the type is for the most part poorly drained.

This soil is of sedimentary origin and represents a sandy covering deposited during the early stages of the Eocene period. In the vicinity of Mount Vernon it was originally heavily wooded with red oak, post oak, and hickory, but in the eastern part of the county the hardwoods were mixed with pine.

On account of the impervious nature of the deep subsoil, the more level areas of the type have a tendency to remain saturated with water during the early spring months. For this reason the soil is somewhat later than the Norfolk fine sand and not quite so well adapted to early truck crops. If properly drained, however, it would be an excellent trucking soil, as its ability to retain moisture would

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be a valuable quality during the dry summer months. Sweet potatoes, Irish potatoes, peanuts, cowpeas, and small fruits should do well and should be made to supplant a part of the cotton and corn. Near Mount Vernon peanuts are grown to some extent, the yield averaging about 50 bushels of nuts and from 1 to 2 tons of hay per acre. Corn yields from 12 to 20 bushels per acre, and cotton from one-fourth to one-half bale. The heavier areas are well suited to Bermuda grass and redtop (*Agrostis alba*).

The land is deficient in organic material and a greater effort should be made to correct the deficiency. Fall oats and winter vetch, pastured throughout the winter months and turned under before the planting of the spring crop, would be a decided benefit in this respect.

There is a low-lying area near White Oak Creek, 4½ miles north of Mount Vernon, which consists in part of a gray fine sandy loam or silty loam from 4 to 10 inches deep, underlain by gray or yellow and gray silty clay. In appearance this material resembles the poorly-drained bodies of Lufkin clay mapped in other areas, but they are all exceedingly small in extent. Scattered over the surface of about one-half of this phase of the type are small rounded mounds from 2 to 4 rods across and 3 or 4 feet in height. These mounds sometimes consist of gray fine sand 3 feet or more in depth, and again of yellowish gray fine loamy sand which is underlain at 20 inches with mottled red and gray sandy clay.

During periods of excessive rain the lower portions of this area are sometimes covered with standing water, which gives the rounded mounds the appearance of little islands separated from each other by winding channels from 2 to 4 rods in width. Although this phase occurs in the bottoms of White Oak Creek it is not, strictly speaking, an alluvial soil. Doubtless the lower occurrences have been influenced in their formation by the overflow waters of the creek, but from the appearance of the red clay subsoil on the mounds it is probable that they are more or less sedimentary.

The principal forest growth is post oak, which is now being removed for posts and ties. None of this phase is under cultivation, and until artificial drainage is resorted to it is not probable that cultivated crops would prove successful. On account of the uneven surface of the land it is best adapted to the growing of grasses to be used for pasturage.

The Caddo fine sandy loam is valued at from $4 to $15 an acre.

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The following table gives the average results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Caddo fine sandy loam.

No.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18317, 18345, 18347 ..	Soil.....	0.2	0.8	0.3	16.1	34.7	38.5	9.7
18318, 18346, 18348 ..	Subsoil ...	.2	.6	.2	13.1	29.2	34.6	22.2

SANDERS SILT LOAM.

The soil of the Sanders silt loam consists of 8 to 15 inches of a gray silt loam, with an average depth of about 1 foot. When in a dry condition the soil has a fine, flourlike texture, and is almost white in color, but owing to the high clay content it becomes very plastic and sticky when wet. The subsoil is a gray or mottled yellow and gray compact silty clay. Both soil and subsoil are marked with brownish-yellow iron stains which become more pronounced as the depth increases.

Because of its small extent the type is not of great importance in the county. It is found as lowlands in the bottoms of White Oak Creek, Big Creek, and Andys Creek, a tributary of Big Cypress Creek.

The topography of the type is level and because of its low position the areas are subject to overflow at any season of the year. The soil has been formed by the deposition of fine material during times of flood, a process which is still going on.

The forest growth consists of white oak, post oak, gum, and sycamore. Dense bodies of wild cane are also found interspersed with areas of Bermuda grass, which makes the type of value as a pasture for cattle and hogs.

Owing to the poor drainage and the frequent overflows none of the soil is under cultivation, and unless artificially protected from floods it is doubtful if cultivated crops would be found profitable upon it. The soil is well adapted to the production of hay, especially Bermuda grass, redtop, and such grasses as are not injured by flooding. The value of the land ranges from $4 to $7 an acre.

The following table gives the results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Sanders silt loam.

No.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18050	Soil.....	0.4	1.8	0.8	10.8	9.2	58.3	18.6
18051	Subsoil	.2	1.6	.8	8.2	9.8	53.7	25.4

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SANDERS CLAY.

The soil of the Sanders clay consists of 6 to 8 inches of a light-gray silty clay. The subsoil to a depth of 3 feet is an ashy-gray, sticky, impervious clay, becoming almost white in color on exposure to the sun. In places both soil and subsoil contain a high percentage of silt and at times a small quantity of very fine sand. When wet the soil is sticky and plastic and the presence of numerous reddish-brown iron stains gives it a slightly mottled appearance, which becomes quite marked in the lower depths.

The soil is notably deficient in organic matter, and if worked when in a wet condition bakes into irregularly shaped bricks, which are slow to break down.

The Sanders clay is the most common lowland soil in the county. The largest bodies are found as strips from 1 to 2 miles wide along the bottoms of White Oak, Cypress, and Brushy creeks. Other irregular bodies are found scattered through the wooded bottoms of Big Creek, Little Cypress, and some of the smaller streams, but the texture is usually quite silty, and as these areas are closely associated with areas of Sanders silt loam they appear on the map with the latter type.

The origin of the type is alluvial, being derived from the materials deposited by the streams in times of overflow. The surface is quite level and most of the soil is flooded several times a year. As the subsoil is close and impervious the removal of the water is slow and as a result the ground is sometimes saturated for weeks. This condition could be much improved by straightening and deepening the numerous bayous which wind through the bottoms. None of the soil is under cultivation, it being covered by a growth of white oak, post oak, and sycamore. Considerable areas are also densely covered by a growth of wild cane, which furnishes a valuable winter feed for cattle.

On account of the frequency with which the land is overflowed the growing of cultivated crops, unless protected from floods, would likely prove unprofitable. In its present condition about the best use to which the land can be put is the growing of Bermuda grass for pasturage. This is a crop which the floods will not ruin, and a field once established will continue to yield luxuriant pasturage for cattle and hogs for many years. On this soil fine yields of Bermuda grass hay could also be secured, a crop which is in demand throughout the county.

In its present wet condition the land is not thought to be very desirable for agricultural purposes, but if artificially drained and protected from floods it should produce the tame grasses as well as the staple crops of the area. The land is valued at $4 to $10 an acre, depending on location and timber growth.

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The following table gives the results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Sanders clay.

No.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18052	Soil	0.0	1.2	0.7	3.6	9.0	52.8	32.3
18053	Subsoil	.1	1.4	.7	3.5	13.8	48.7	32.7

MEADOW.

Meadow includes a soil of varying texture and agricultural value. The surface material consists of light-colored silty sand and fine sandy loam, mixed with small areas of gray silt loam and silty clay. The subsoil varies from a gray fine sandy loam to a silty clay loam or clay. Below the second foot the color is frequently marked with reddish-yellow stains due to the presence of iron washed in from adjacent types. Narrow strips of Meadow are found along the smaller streams in all parts of the county, the most important bodies occurring in the vicinity of Mount Vernon and along Panther, Big Cypress, and Brushy creeks.

The type is all level, and most of it is subject to overflow at any season of the year. Only a very small proportion of the type is under cultivation, the remainder being occupied by forests of white oak, post oak, ash, and hickory.

Sugar cane does especially well on this soil, and has proven very profitable. The yield ranges from 250 to 500 gallons of sirup per acre, which sells for from 35 to 50 cents a gallon. The type if drained and protected from overflows would be well adapted to the growing of corn and grasses. Even under present conditions Bermuda grass thrives and furnishes a large area of pasturage. Corn yields from 25 to 40 bushels, and cotton from one-half to 1 bale per acre. In its present condition most of the soil is uncertain for cultivated crops. On many of the sandy bodies along the smaller streams, however, drainage could be easily effected by straightening the streams and constructing lateral ditches, in which case the soil would be one of the most valuable in the county.

The value of this type of land ranges from $3 to $10 an acre, the higher value being due to valuable timber growth.

SUMMARY.

Franklin County is located near the northeast corner of the State, on the line between the east Texas timber belt and the black land region of central Texas. The surface is level to rolling and the drain-

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age is good. Mount Vernon and Winnsboro are the chief towns and shipping points, the former being the county seat.

The climate is mild and agreeable. Planting can be done throughout every month of the year, and the growing season is such that the fields can be made to mature two crops before the appearance of killing frosts.

Cotton and corn still continue to be the chief crops grown, although in the vicinity of Winnsboro the peach industry has been widely extended, there having been half a million trees set out during the past three years. More attention should be given to the production of live stock, and more forage crops should be grown. The county has several soils which if properly drained would be suited to the growing of alfalfa. These are the Houston clay, Wabash clay, Sanders clay loam, Wilson clay loam, and Wilson loam.

The soils of the county are rather complex, falling naturally into 9 general series and being again divided into 16 distinct types. These range from the dark heavy clays of the Sulphur River bottoms to the light textured Norfolk sands.

The most extensive soil is the Susquehanna fine sandy loam, which like the Norfolk fine sand is well adapted to fruit, berries, and truck.

The Lufkin fine sandy loam is an extensive type in the northern part of the county and is valued as a range for stock and for the production of wild hay.

The Sanders clay, Sanders silt loam, and Meadow are lowland soils occurring in all parts of the county. On account of the loss from overflows very little of these soils are under cultivation. They are adapted to Bermuda grass, redtop, and, where well drained, to sugar cane.

The Caddo fine sandy loam is a type of wide distribution and is fairly well adapted to fruit and early truck crops.

The Orangeburg sand is of very limited extent, but is one of the best peach soils in the country.

The Lufkin silt loam, Susquehanna clay, Norfolk fine sandy loam, and Lufkin fine sand are all of very small extent and of little agricultural importance.

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SOIL SURVEY OF CAMP COUNTY, TEXAS.

By W. J. GEIB, E. B. WATSON, THOMAS D. RICE, and CLARENCE LOUNSBURY.

DESCRIPTION OF THE AREA.

Camp County is located in the northeastern part of the State of Texas, in the east Texas timber belt, about 40 miles west of the eastern boundary and 50 miles south of the northern boundary of the State. The ninety-fifth meridian, west longitude, passes through the county a little west of the center, and the thirty-third parallel, north latitude, crosses the county near the center. It is bounded on the north by Titus and Morris counties, on the east by Morris

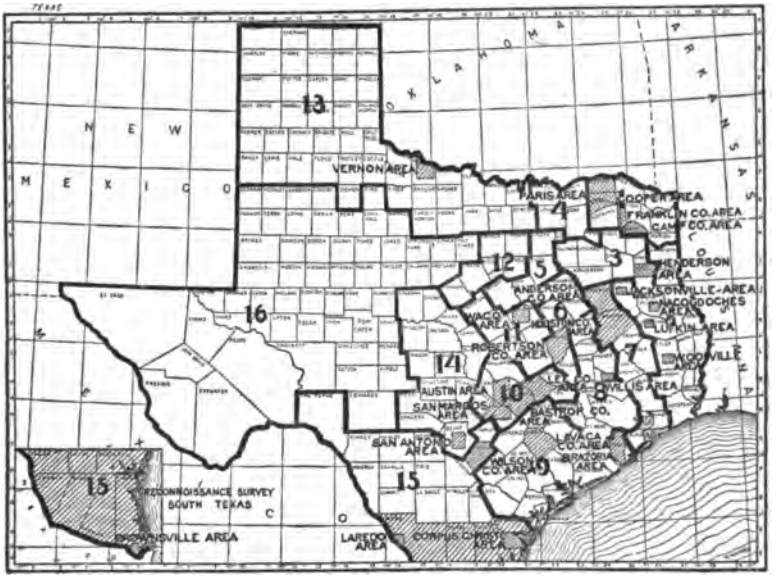

FIG. 25.—Sketch map showing location of the Camp County area, Texas.

County, on the south by Upshur County, and on the west by Wood and Franklin counties. It is one of the smallest counties in the State, containing 129,920 acres or 203 square miles.

The elevation varies from about 200 feet above sea level, in the southeastern corner on the flood plain of Big Cypress Creek, to about 500 feet on the near-by hills. The library building at Pittsburg has an elevation of 398.7 feet. Big Cypress Creek receives most of the drainage and forms about one-half of the boundary of the county. Starting from the western side, it flows first northeast, then east,

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and finally southeast to the southern boundary. Prairie and Richland creeks are its principal tributaries. The southwestern portion of the area is drained by Lilly Creek south into Little Cypress Creek, which unites with Big Cypress Creek about 30 miles southeast of the county.

The topography is for the most part gently rolling. There is just enough slope from the uplands to the stream bottoms to insure good drainage, except on the bluff line adjoining the bottoms of Big Cypress Creek, where the fall is so great as to cause rapid erosion, but as a rule this is not sufficient to prevent cultivation. Extensive bottom lands border Big Cypress Creek and extend along its principal tributaries. These are subject to overflow and only a small portion is cultivated. In the southeastern part of the county some rocky hills occur, known locally as "mountains," which are from 250 to 300 feet above the flood plains of the streams at their base. These, however, occupy only a small area and are too steep and rough for cultivation.

The first settlers came to Camp County in 1844 and located on Big Cypress Creek. A few others came in 1850, and quite an inflow occurred in 1855, and another in 1859. Almost all of these immigrants came from the more eastern Southern States, particularly Georgia and Alabama, and took up the greater part of the land that is cultivated to-day. Since the civil war the population has increased steadily, until now it numbers 9,000, about 55 or 60 per cent being native white and the remainder colored. There are practically no foreigners in the county.

The first survey of land was made in 1849, when a number of "headrights" which had been given to veterans of the Mexican war were located. These "headrights," according to old Spanish customs, usually consisted of a league and a labore or 4,605.5 acres. They were located at the option of the holders, and the best land was chosen, but with no regularity or general order. These old grants are the basis of all land titles at the present time, thus making the description of land radically different from that in a sectionized country. Pieces of land left between these original surveys were surveyed later and bought from the State. The last thus secured was some river bottom land that was deeded by the State only last year.

Camp County was originally a part of Upshur County, but in 1876 was organized as a separate county. Pittsburg, situated near the center of the county, is the county seat and only town of any importance. It has a population of about 2,000 and contains a cotton compress, an oil mill, a box factory, and other minor industries. Leesburg has a population of about 200. Pine, Newsome, Harvard, and Faker are shipping points.

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Before the advent of the railroad, Jefferson, 40 miles southeast of Pittsburg, was the marketing point for cotton, which was the only export from the county. In 1878 the Missouri, Kansas and Texas Railway was completed, traversing the county from east to west, and soon after the Cotton Belt Route (St. Louis Southwestern Railway) was built, crossing the county from north to south. Both roads pass through Pittsburg and offer excellent transportation and marketing facilities. Almost all the cotton for shipment out of the State goes to Galveston, and that for Japan is sent to Seattle. Potatoes and fruit are shipped to all parts of the country, but principally north. Corn, hay, and forage crops are marketed within the county.

CLIMATE.

The climate of Camp County is mild and pleasant. According to the Weather Bureau station at Paris the average number of days for the ten years ending 1903 on which the temperature exceeded 100° F. was seventeen each year. From the last killing frost in the spring until the first in the fall there is a period of about eight months, thus giving a long growing season. From October until June the weather is delightful, the majority of the days being bright and pleasant and the nights cool. Plowing and all kinds of farm work can be done every month in the year, and live stock needs little protection. An occasional fall of temperature occurs, due to sudden cold waves from the north called "northers," but these rarely last more than two or three days and are not frequent.

The following tables, compiled from the records of the Weather Bureau stations at Paris and Sulphur Springs, give the normal monthly and annual temperature and precipitation at these places, which are only a short distance outside of the area:

Normal monthly, seasonal, and annual temperature and precipitation at Paris.

Month.	Temperature.			Precipitation.			
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year.	Total amount for the wettest year.	Snow, average depth.
	°F.	°F.	°F.	Inches.	Inches.	Inches.	Inches.
December	46	80	5	2.1	1.9	3.4	0.5
January	45	83	8	2.1	3.1	.4	1.8
February	44	84	−13	2.0	.3	2.2	1.4
Winter	45	.....	.....	6.2	5.3	6.0	3.7
March	55	92	18	3.5	.6	4.0	0.0
April	65	96	29	2.9	3.2	4.7	0.0
May	71	96	38	4.5	2.4	4.3	0.0
Spring	64	.....	.....	10.9	6.2	13.0	.0

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Normal monthly, seasonal, and annual temperature and precipitation at Paris—Cont'd.

Month.	Temperature.			Precipitation.			
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year.	Total amount for the wettest year.	Snow, average depth.
	°F.	°F.	°F.	Inches.	Inches.	Inches.	Inches.
June	78	104	46	3 3	1.2	2.0	0.0
July	83	108	60	3.1	1.5	4.6	0.0
August	82	110	57	2.0	Trace.	.1	0.0
Summer	81	.....	.....	8.4	2.7	6.7	0.0
September	76	106	42	2.8	.6	6.7	0.0
October	66	95	33	2.3	3.0	3.8	0.0
November	54	85	18	2.7	.6	11.9	0.0
Fall	65	.....	.....	7.8	4.2	22.4	0.0
Year	64	110	−13	33.3	18.4	48.1	3.7

Normal monthly and annual temperature and precipitation at Sulphur Springs.

Month.	Temperature.	Precipitation.	Month.	Temperature.	Precipitation.
	°F.	Inches.		°F.	Inches.
January	47.8	2.51	August	83.4	2.51
February	45.8	2.30	September	78.4	2.93
March	57.0	3.90	October	67.8	3.16
April	66.0	3.15	November	53.8	3.39
May	70.7	4.84	December	46.6	3.10
June	80.3	3.01			
July	83.1	4.44	Year	65.3	39.24

From the table it will be seen that the hottest months—June, July, August, and September—have an average temperature of 80° F., while the coldest months—December, January, and February—have an average of 46° F.

The rainfall is ample, being 33.3 inches at Paris and 39.2 inches at Sulphur Springs, and is well distributed throughout the year. Dry years, however, occur occasionally and cause considerable loss. During the driest year at Paris there was only 18.4 inches of rainfall, and during the four hottest months only 3.3 inches. On the whole the climate is very favorable to the growth of cotton, vegetables, fruit, and a great variety of crops.

AGRICULTURE.

Camp County was originally covered with valuable forests of shortleaf pine and oak. Hickory, ash, birch, willow, bois d'arc, gum, cottonwood, black walnut, loblolly pine, honey locust, box elder,

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dogwood, ironwood, persimmon, holly, etc., occurred as minor growths. Lumbering has been an important industry, and there is still much timber left standing, especially on the bottoms. There are now five sawmills in the county with an annual output of products valued at $20,000.

To clear a piece of land it was the custom of the early settlers to cut out the smaller growth and deaden the large trees, after which cotton or corn was planted among the stumps. Later the large trees were removed and burned. This practice is still followed when a new field is cleared, and much valuable timber has been wasted in this way. The owners of timbered lands would do well to look into the question of a rational system of forestry, for it is probable that no better use will ever be found for the rough hills and a large proportion of the bottom lands than to keep them forested.

The early settlers used the unfenced and uncleared areas as range for stock, especially cattle and hogs. As the population and area of cleared land has increased, laws have been passed in a major part of the county restricting the free range. At present in the more thickly populated districts all stock is restricted, and this has been a factor in improving the quality of farm animals generally. The large bottom areas and some of the rougher land are still free range and afford much valuable pasturage.

The poultry industry is well developed. In addition to supplying the home demand, several cars of chickens and turkeys, besides great quantities of eggs, are shipped out of the county each year.

Cotton has been the leading crop from the first, and to-day the area devoted to it is as large, if not larger, than that of all other crops combined. The short-staple variety is mostly grown, and the grades in 1908 ran from low ordinary to middling fair, averaging about middling. Long-staple cotton, however, is being tried as an experiment, and 10 bales were marketed this year, commanding an advance of 1½ cents a pound over the short-staple variety. If a permanent market were established in the county for this class of cotton, a higher price would undoubtedly be secured, but it is not yet certain that it will prove more profitable on the soils of the area than the short-staple variety.

The method of cultivating cotton has been in the main that followed throughout the cotton-growing States; that is, ridge culture, plowing and cultivating with single mules, and using a large amount of hand work. The early custom was to grow cotton continuously on a field until its productiveness became so low that it no longer produced good yields. It was then abandoned and a new field cleared. The abandoned field was allowed to grow up in old field pine, sweet gum, or other timber of low value, and in the course of time it was again cleared. Fortunately this custom is dying out, though it has not entirely disappeared.

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Cotton gins are numerous throughout the county, and the usual toll is from one-sixteenth to one-twentieth of the cotton ginned. The owner of the cotton receives the seed, which for each bale of cotton is worth about $6.

The boll weevil has been in the county about four years, and has considerably decreased the yield of cotton, but not to such an extent as it has farther south. The farmers are learning to combat it by planting earlier varieties of cotton, adopting cleaner methods of culture, and especially by turning their attention to the introduction of other crops. During the last five years there has been quite an awakening along agricultural lines and new crops and new methods are being tried.

Corn is an important crop and its acreage has increased until it is now about one-half that of cotton. All corn and forage crops not consumed on the farms are marketed within the county. Bermuda grass is now well established, and during the last five years has become a profitable hay crop. On the bottoms it yields from three to four cuttings a year of about 1 ton per acre to the cutting, and on the uplands it gives about half as much. In all probability the acreage devoted to this crop will be extended until the county produces all the hay needed for its live stock.

About ten years ago a large peach orchard was set out, and when it came into bearing it demonstrated the possibilities of fruit growing in the county. During the last five years many peach orchards, containing from 1,000 to 5,000 trees, have been set out, and also a few pear orchards. The soil and climate seem especially suited to the production of fruit. The finest grade of Elberta peach is produced, and failures are very few. There is a local fruit growers association that markets the fruit, but the last season was the first year that they have handled fruit in any great abundance. The fruit was not properly graded and packed and consequently many losses resulted. In some cases the sales did not equal the cost of freight and commission charges. Some growers did well with their fruit, but more of them lost money. If the fruit raisers can be induced to cooperate and master the art of grading, packing, and marketing, results will be far different. Undoubtedly fruit of great excellence can be produced at a small cost. In 1908, 48 carloads of peaches were shipped from Pittsburg and many orchards are not yet of bearing age. Several farmers have secured small canning outfits and can their peaches for market. This has proved quite profitable. Not only do they can peaches, but also sweet potatoes, beans, tomatoes, and other truck. The canning industry bids fair to develop, and it is possible that it will solve the problem of marketing, for the product when canned may be held and sold as the demand arises.

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The trucking industry is also receiving increased attention. Of the truck crops, Irish potatoes lead. They are raised for the early northern markets, arriving there long before the northern-grown potatoes mature. The yields are not large, ranging from 25 to 125 bushels per acre, with an average of 50 or possibly 60 bushels per acre. The price is very satisfactory, the growers netting for the last two years a little more than 80 cents a bushel. In 1907, 52 carloads of potatoes were shipped and 64 carloads in 1908. These are dug early enough to allow time for some second crop. This is often potatoes again, grown for next year's seed, sweet potatoes, or corn, all of which do well. Sweet potatoes are mostly grown for home consumption, but 3 or 4 carloads are shipped. Tomatoes, beans, and other truck crops are also grown and shipped to some extent.

Although sugar cane is not given a large acreage, being grown mainly in small areas on sandy bottoms, the yield is so great that the industry is of considerable importance. Several carloads of cane are shipped each year to the western part of the State, where it is retailed for direct consumption. The greater proportion of the crop, however, is made into what is called "ribbon-cane sirup," at the many small cane mills located over the county. In addition to supplying the local demand for sirup, about 4,000 gallons are shipped annually. The average price is 50 cents a gallon.

Other minor crops receiving some attention are peanuts, which are grown for stock feed, and cowpeas, oats, and rye for hay and winter pasturage.

Commercial fertilizers have not been used to any great extent. They were tried and for a while the amount used increased each year, but now it is decreasing. In its stead the farmers are using barnyard manure, which is now being largely saved, and they are beginning to grow cowpeas and other leguminous crops to restore the productiveness of the soil.

Fully half the farms in the county are operated by the owners. The average size of the farms is 69.5 acres.[a] Share rent is the universal custom, the usual rent being one-third of the corn and one-fourth of the cotton. Occasionally the landlord furnishes everything—stock, implements, and seed—and in return he receives one-half the crop. Many of the renters are entirely outfitted by the landlord, and by the time the crop is harvested, if not before, they have the value of the crop spent, leaving them destitute at the end of the season. Farm hands receive $18 a month, with board, but not many are employed. If an owner is unable to cultivate all his land, some of it is rented.

[a] The Census tabulated each tenancy as a farm, and the average size of individual holdings is probably much larger than this figure.

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A large proportion of the farm work is performed by negroes, who constitute 40 or 45 per cent of the population. They are industrious and economical, about one-third of them owning the farms which they operate, and most of those who own farms are free from debt. Quite a number own from 100 to 500 acres each.

Over half of the county, possibly as much as 60 per cent, is cleared and improved. This area has a population, not including that of the towns, of about 60 to the square mile. Public schools are numerous and well supported, there being separate schools for white and colored children.

Some of the rougher land in the southeastern part of the county changed hands recently at $1 an acre, while some of the swamp land is worth but little more than the value of the standing timber. The Susquehanna gravelly loam, on the breaks of Big Cypress Creek, is worth from $4 to $8 an acre. The more level and better farming land, especially the Norfolk fine sandy loam, is valued at $10 to $20 an acre. Pittsburg land values are somewhat higher.

The farmers of the county are progressive, and their agricultural methods are in advance of those found in many parts of the South; still there is room for improvement. As already stated, cotton is especially suited to the soil and climatic conditions, but a field should not be grown continuously to cotton until worn out, as is too often done in the county. Some systematic rotation can easily be planned that will give a profitable yield each year, and with an occasional dressing of barnyard manure the productiveness of the soil can be maintained indefinitely without the use of commercial fertilizers. A legume should be included in the rotation, and legumes should also be grown as catch crops before or after the main crop of the season. Cowpeas, peanuts, and many other legumes do well here and more attention should be given them.

Level culture should take the place of the ridge culture of cotton. The fields should be cleared of stumps as soon as practicable to facilitate the use of 2-horse tools and improved cultural implements. A field once cleared should never be abandoned, but some system of soil management should be adopted whereby it would continue to produce profitable yields. The first step in this direction is a rotation of crops, as mentioned before. It is also important to maintain the humus content of the soil. Cotton culture exhausts the humus very rapidly, because of the clean culture given the crop, and for this reason fresh organic matter should be added to the soil as frequently as possible. The exclusive use of commercial fertilizers is to be discouraged, and barnyard and green manures should be liberally employed. Cultivation, especially of the cornfields, should be more thorough. The abundance of cockleburs, as well as numerous other

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weeds that go to seed, is quite noticeable, and if not kept down this proves a serious hindrance to the growth and yield of the crop.

More care should be taken to prevent erosion, especially on the Susquehanna soils. This can be done by terracing and running the rows with the contour of the hills.

A proper expansion of the truck and fruit industry is desirable. Lespedeza grows wild here, and it is probable that its culture would be very profitable.

SOILS.

The soils of Camp County fall into four series—the Susquehanna, Caddo, Norfolk, and recent alluvial or meadow soils. Geologically the area lies within the outcrop of the Lower Eocene, known as the Sabine formation, which consists of sands, with laminated clays and some lignite. In places the sands have been indurated into a ferruginous sandstone by the presence of oxide of iron, and the amount of iron at times is sufficient to constitute an iron ore. Where the sandy strata outcrop on the hillsides springs arise, there being a number of very valuable springs in the county.

The Sabine formation, being uncovered, has weathered into the three types of the Susquehanna series. The Caddo fine sandy loam, or the post-oak flats, has probably been derived from the same formation, where for some reason it has never had a covering of the overlying Lafayette, or at best but a very thin one. Its position would preclude the possibility of its being uncovered by erosion, for it occurs on very poorly drained level places.

Resting upon this formation, except on a few of the higher hills, and lower down where removed by recent erosion, is a yellow or gray sand and sandy clay deposit nearly free from gravel, usually not exceeding 5 or 6 feet in thickness, though in places it is 10 to 20 feet. The age of this superficial deposit is not established, but it is thought to be redeposited Lafayette, possibly representing Port Hudson. .This formation has given rise to the Norfolk fine sand and fine sandy loam, which are the prevailing types over the level part of the county and constitute the most highly prized farming land. It seems probable that this formation was a water deposit and originally covered, probably to a depth of 10 to 15 feet, the surface of the entire county, with the possible exception of some of the highest hills, and followed the topography of the underlying formation, which already had its drainage well established and was considerably eroded. As was natural on its elevation above the sea, the soil was soon washed off the steeper slopes, but has remained on the uplands and in many cases below the steeper slopes on the bottoms of the smaller streams.

Along the large streams there has been a recent deposit of alluvial material, which is simply a reworking of the other soils of the area, and these constitute the Meadow soils.

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The following table gives the names and areas of the several soils, while the accompanying map shows their distribution:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Norfolk fine sandy loam	61,184	47.1	Susquehanna stony loam	1,024	0.8
Susquehanna fine sandy loam	23,360	18.0	Caddo fine sandy loam	384	.3
Meadow	19,776	15.2	Total	129,920	.....
Susquehanna gravelly loam	19,328	14.9			
Norfolk fine sand	4,864	3.7			

NORFOLK FINE SANDY LOAM.

The surface soil of the Norfolk fine sandy loam, to a depth of 12 to 20 inches or more, is a gray fine sandy loam. The subsoil, to a depth of 3 to 10 feet, consists of a yellow sandy clay underlain by a stiff clay. Both soil and subsoil, when typically developed, are free from gravel and very uniform in texture, the only exception being where the formation is quite thin. Here it has become partly mixed with the underlying Susquehanna and the subsoil in this case often becomes reddish or chocolate in color.

The soil is derived from the youngest sea deposit, probably Port Hudson, and with the exception of a few eroded places it is practically unmodified. The topography is usually level or gently rolling. Occasionally the drainage is inadequate.

The original timber growth consisted of pines and hardwoods. When first cleared the soil contains a good proportion of humus and is very productive. It is the leading farming soil of the county and occurs in large bodies over the main uplands and along the upper courses of the small streams in the central and southern portions of the area. It is very easy to cultivate and the subsoil contains enough sand and silt to make it fairly pervious to water. Most of the type is cleared and under cultivation, very little having been abandoned when once cleared. It is not as early a soil as the Susquehanna gravelly loam, but it withstands drought much better.

Cotton and corn are the principal crops grown on this type. Cotton yields from one-fourth bale to 1 bale per acre, averaging before the advent of the boll weevil somewhat more than one-half bale. The weevil has reduced the yield probably one-fourth, possibly one-third. Corn yields from 10 to 40 bushels per acre, averaging about 20 bushels. The greater part of the fruit and truck is grown on this soil. Peanuts, oats, cowpeas, and Bermuda grass all do well.

Level culture and rotation of crops, including legumes, are recommended for this soil. Though it responds well to commercial fertilizers, many of the farmers prefer barnyard manure, which is gradually taking the place of the fertilizers.

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Land of this type is worth from $8 to $20 an acre, and near Pittsburg it is somewhat higher.

The following table gives the average results of mechanical analyses of typical samples of soil and subsoil of the Norfolk fine sandy loam:

Mechanical analyses of Norfolk fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
20029, 20031	Soil	0.0	0.2	0.9	28.8	43.1	22.4	4.6
20030, 20032	Subsoil	.1	.1	.8	30.3	29.3	19.2	19.4

NORFOLK FINE SAND.

The soil of the Norfolk fine sand, to a depth of 6 inches, is a gray medium or fine sand containing a small amount of organic matter in the surface when first brought under cultivation. It grades imperceptibly into the subsoil, a gray, uniform, medium sand free from gravel, which extends to a depth of from 3 to 15 feet.

The topography consists of a level or gently rolling surface, the latter often being deeply eroded. Like the Norfolk fine sandy loam, it is derived from the latest Quaternary formation. The original forest growth consisted almost entirely of pine with a few deciduous trees.

The Norfolk fine sand is not an extensive type and is confined to the southwestern part of the county. It is not highly esteemed for agricultural purposes, for it soon declines in productiveness, and does not withstand drought well. Having a loose and porous structure, it is the most easily cultivated soil in the area, and is especially adapted to early truck crops, both fruit and vegetables doing well. Cotton yields from one-fifth to one-half bale per acre, and corn 10 to 18 bushels. Peanuts do well.

Not a large proportion of this type is under cultivation. Some of the once cultivated fields have been abandoned and now support a growth of old-field pine. In many of the fields the organic matter content of the soil has become noticeably deficient. This can best be remedied by growing leguminous crops, preferably in a regular rotation. This soil is valued from $3 to $8 an acre.

The results of mechanical analyses, showing the texture of the soil and subsoil, are given in the following table:

Mechanical analyses of Norfolk fine sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
20,027	Soil	0.0	1.5	11.4	64.3	15.6	5.1	2.1
20,028	Subsoil	.0	1.5	11.4	65.8	15.2	3.9	2.3

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SUSQUEHANNA FINE SANDY LOAM.

The Susquehanna fine sandy loam, to a depth of 6 to 12 inches, is a gray fine sandy loam, containing a small amount of gravel made up of iron sandstone and iron concretions. The subsoil consists of a tenacious red plastic clay, containing but little sand or gravel, usually mottled with yellow and occasionally blue clay in the lower depths. In certain very small areas the subsoil is yellow. The clay is markedly stratified, and in the lower depths the strata often range from stiff or sandy clay to iron sandstone.

The topography is level to rolling. Where nearly level, the soil sometimes lacks good drainage because of its impervious subsoil. As a rule, the surface drainage is sufficient to carry off the surplus water, but often erosion must be guarded against. A few fields have been abandoned on this account, but by terracing and careful culture this could have been prevented.

This type occurs along the lesser stream courses and on the low divides between them. It is formed by the exposure and weathering of the Sabine formation, where erosion has not been too rapid.

The original forest growth consisted of hardwoods, with a small amount of pine. Most of this forest has been removed and the land brought under cultivation, and while not as highly valued for agricultural purposes as the Norfolk fine sandy loam, still with good management it is quite productive. Its structure is loose and porous and cultivation is easy. Green manuring is found very profitable and is to be advised. If the humus is kept replenished, the soil will withstand continued cultivation.

The Susquehanna fine sandy loam is adapted to a great variety of crops, such as cotton, corn, oats, cowpeas, and Bermuda grass. Cotton usually yields from one-fourth to three-fourths bale per acre, averaging less than one-half bale. Corn produces from 10 to 25 bushels per acre. This soil is worth at present from $5 to $15 an acre.

The following table gives the average results of mechanical analyses of fine-earth samples of the soil and subsoil:

Mechanical analyses of Susquehanna fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
20033, 20035	Soil	1.1	1.0	0.8	20.2	41.1	30.8	4.8
20034, 20036	Subsoil	.2	.8	.4	10.8	23.1	24.6	39.9

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SUSQUEHANNA GRAVELLY LOAM.

The soil of the Susquehanna gravelly loam, to a depth of 10 to 20 inches, consists of a reddish-gray medium sandy loam, containing a large proportion of gravel made up of iron sandstone and iron concretions. The subsoil consists of a red clay, mottled with yellow or gray, and contains considerable gravel similar to that of the soil. This gravel content renders the clay pervious to water and coupled with the good surface slope gives the soil good drainage, but, on the other hand, the type does not withstand drought very well.

The topography is rolling to steep, occurring along the bluffs of the larger streams where erosion has been rapid. The soil varies a good deal, owing to its topography, and occasionally areas of Susquehanna fine sandy loam, too small to be mapped, are found where erosion has not been so rapid. It occurs mostly in the northern part of the county near Big Cypress Creek.

The original timber growth consisted of deciduous trees, mostly hardwoods, and more black-jack oak is found on this soil than on any other in the area. About half the type has been cleared and cultivated.

The Susquehanna gravelly loam is an early soil, adapted to all the staple crops of the county, especially truck and fruit. Cotton and corn are the principal crops. Cotton averages one-third bale per acre, but with good culture it yields 1 bale to the acre. If an early variety is planted the crop is made before the boll weevil becomes very destructive. Corn yields from 10 to 20 bushels per acre. Peaches seem to do well and many of the large peach orchards have been set out on this type. Truck has not been tried extensively, but the soil is undoubtedly suitable. Grapes would probably do well.

Owing to its topography the soil is apt to erode rapidly, and under poor management it quickly declines in productiveness. Some fields have been abandoned. Terracing and careful culture, running the rows around the hills, are most essential. Surface cultivation to conserve the moisture should be practiced, and heavy applications of organic matter should be made, as the soil is deficient in humus. The value of the land varies from $4 to $12 an acre.

The following table gives the results of mechanical analyses of fine-earth samples of the soil and subsoil:

Mechanical analyses of Susquehanna gravelly loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
20039	Soil	0.5	1.0	0.3	14.8	51.9	26.5	4.7
20040	Subsoil	1.0	1.4	.5	25.2	32.3	21.7	17.9

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SUSQUEHANNA STONY LOAM.

The Susquehanna stony loam is not very uniform in character, but where typically developed it consists of a gray or reddish-gray sandy loam, 6 to 12 inches deep, in which occurs a great number of stones of varying size. The subsoil differs from the soil in that it contains more clay, often red in color, and frequently more rock fragments. These fragments are ferruginous sandstone and consist of sands which have been cemented into a fairly hard stone by iron oxide.

The type is found in the rough, hilly section, locally known as the "mountains," in the southwestern part of the county. A few small areas outside the area just described have been included in this type. They consist of especially rough spots in the Susquehanna gravelly loam, where erosion has been very severe and has left a soil very stony and unfit for cultivation.

The soil is uncultivated because of its stony character and rough topography. It is used for stock pasture or valued for the timber, consisting of shortleaf pine, white, post, and black-jack oak, hickory, and minor growths. The price of this land is very low, $1 to $3 an acre.

The following table gives the results of mechanical analyses of fine-earth samples of the soil and subsoil:

Mechanical analyses of Susquehanna stony loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
20037	Soil	0.4	1.9	0.8	28.4	37.1	25.6	6.0
20038	Subsoil	.2	.7	.3	17.2	48.8	23.9	8.7

CADDO FINE SANDY LOAM.

The soil of the Caddo fine sandy loam, to a depth of 3 to 8 inches, and occasionally 12 inches, is a very fine sand containing considerable clay and usually gray in color. The subsoil is a very tenacious, impervious clay of varying color, being usually gray with a few mottles of yellow or red, though sometimes it is brown. Scattered over the surface and covering nearly one-half the type are small, rounded mounds of fine sand or fine sandy loam from 1 to 4 feet high and 2 to 4 rods wide. These resemble small dunes, and probably owe their origin to an accumulation of sand around small tufts of vegetation when the country was in an arid condition.

The general topography of the soil is quite level. It occurs as poorly drained areas in the uplands some distance from the streams and is of very limited extent, only a few small areas being mapped

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in the southwestern part of the county. These are locally known as "post-oak flats." The original timber growth consisted mainly of post and black-jack oak.

The soil is quite refractory to handle, because of its large clay content and undrained condition. It is rather unproductive and is cold and backward in the spring. Water remains in depressions until evaporated. It is claimed that if brought under cultivation it will improve with age, finally becoming fair farming land, but as yet little of it has been cleared. The great need of this soil is artificial drainage. When this is secured it should prove a good, durable soil well suited to cotton and corn. In its natural condition it makes good pasture. Cotton yields as high as one-half bale to the acre, and corn in favorable years 20 bushels per acre. Bermuda grass does well. Land of this type is worth from $5 to $10 an acre.

The following table gives the results of mechanical analyses of the soil and subsoil:

Mechanical analyses of Caddo fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
20025	Soil	0.0	0.9	0.3	13.2	14.0	45.6	25.7
20026	Subsoil	.0	.3	.2	7.6	11.0	45.9	34.1

MEADOW.

The Meadow varies considerably in texture. It is recent alluvial in origin and has the character of the adjacent soil from which it is derived. That along Big Cypress Creek has a heavier texture than that occurring along the smaller streams, much of which is quite sandy.

Very little of this type is under cultivation, as it is all subject to overflow. Occasionally a small area, a few feet higher than the surrounding bottom, is cleared and cultivated and is very productive. Sugar cane and Bermuda grass are the two main crops, both doing exceedingly well.

This soil was originally covered with a heavy growth of deciduous trees, consisting mostly of oaks of various species, hickory, ash, elm, and gum. The mast from these furnishes valuable feed for hogs.

It is probable the chief value of Meadow is in its timber growth, though Bermuda grass for pasture may be successfully grown, as it is seldom injured by overflow. Meadow land has a value of $3 an acre and upward, depending on the amount of standing timber.

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SUMMARY.

Camp County, one of the smallest in Texas, is located in the east Texas timber belt, in the northeastern part of the State. It has an elevation of 200 to 500 feet above sea level.

The surface features are gently rolling over most of the county, and drainage is well established.

The county was first settled in 1844, the settlers coming almost entirely from southern States east of the Mississippi River. Pittsburg is the county seat and commercial center. Two railroads pass through the town and furnish good shipping facilities.

The climate is mild and healthful, and especially favorable to the growing of cotton, fruit, and truck. The annual rainfall, about 35 inches, is well distributed throughout the year.

The county was originally covered with shortleaf pine and oak. Some timber yet remains, especially in the bottoms, but over half the area is cleared and under cultivation. Cotton is the main crop, with corn second. Both fruit and truck are receiving increased attention. Bermuda grass is also grown for hay. There is a fair supply of live stock of good quality.

Most of the good farming land can be bought for $5 to $20 an acre. Agricultural methods are being changed for the better, but more attention should be given to crop rotation, the growing of leguminous crops, the use of barnyard manure, and improved methods of culture.

Seven soils were found in Camp County. These vary in texture from fine sand to heavy loam. They are adapted to a wide range of crops and, for the most part, are easily cultivated.

The Norfolk fine sandy loam is the most extensive soil in the area, as well as the most highly prized. It is suited to the staple crops, fruit, and truck.

The Norfolk fine sand has little agricultural value and is not extensively farmed, although all crops do fairly well for a few years after the land is cleared.

The Susquehanna fine sandy loam, because of its impervious subsoil, is rather difficult to manage, but it is well esteemed and is adapted to a wide range of crops.

The Susquehanna gravelly loam is quite rolling. It is an early soil, and while the staple crops do well, it is especially adapted to fruit and truck.

The Susquehanna stony loam is too rough for cultivation, and is devoted to pasture and forestry.

The Caddo fine sandy loam is of very limited extent. Owing to its impervious nature and poor drainage it is a cold, hard soil to handle.

All the Meadow is subject to overflow. It is valued for pasture and its standing timber.

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SOIL SURVEY OF OVERTON COUNTY, TENNESSEE.

By ORLA L. AYRS and D. H. HILL.

DESCRIPTION OF THE AREA.

Overton County, Tenn., lies in the north-central part of the State, or in the northeastern part of the division commonly known as Middle Tennessee. It is bounded on the north by Clay and Pickett counties, on the east by Fentress County, on the south by Putnam County, and on the west by Jackson County. It is the second county south of the Kentucky State line. There are in all 277,312 acres, or about 433 square miles, in the county.

The Cumberland Plateau and the mountains forming its western front occupy the southeastern third of the county, and a chain of

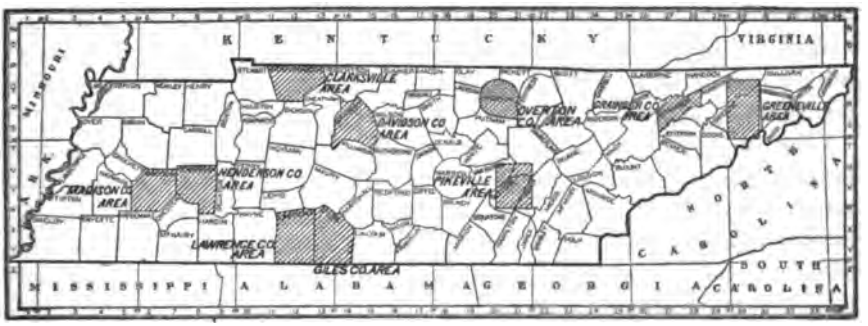

FIG. 26.—Sketch map showing location of the Overton County area, Tennessee.

outlying ridges extends out from the Cumberland Mountains in a northwestern course across the center of the county to within a few miles of the northwest boundary. This region is characterized by bold, rugged mountain topography, having a range in altitude from 700 to 2,000 feet. Lying immediately west of this, and reaching out from the foot of the mountains to the county boundary, is a broad, gently rolling plain, belonging to the Highland Rim of Tennessee and having an altitude varying from 900 to 1,000 feet. On the Highland Rim in the southwestern fourth of the county the surface is characterized by broad, level areas and low, rolling hills. Near the west line of the county, however, this plain has been dissected by the deep, narrow, V-shaped valleys of Spring Creek and Roaring River. The bottoms of these valleys approach the level of the Central Basin,

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which lies farther west, and their escarpments are rough and steep. To the north of this and west of the outlying mountain range previously mentioned, Mill Creek, Mitchell Creek, and their tributaries have destroyed the characteristic features of the Highland Rim, leaving a series of rough, broken ridges. North of the mountains, and along the northeastern boundary of the county, the plain of the Highland Rim again appears. This is cut by the valleys of Eagle Creek and the West Fork of Obey River and their tributaries.

The drainage of the area is all toward the Cumberland River, which lies a few miles beyond the western boundary of the county. The larger streams flow through deep, narrow valleys, and have swift currents.

A permanent settlement in the area was established at Hilham in 1800. Two other settlements were made, near the present site of Livingston, before this, but their exact date is not known. As early as 1770 the region had been occupied by hunters for some time, but they made no permanent settlement. The county was organized in 1806, and at that time included the territory now comprised in the counties of Fentress and Pickett and parts of Clay, Putnam, Cumberland, Morgan, and Scott. The county seat was established at Monroe in 1810, where it remained until about 1835, when it was moved to Livingston, the present county seat. Most of the early settlers came from East Tennessee, Virginia, North Carolina, and Kentucky, and a few from the New England States.

Overton County was progressive and prosperous, and compared favorably with other sections of the State up to the era of railroad construction about 1860. The railroads naturally avoided the rough, mountainous country, and this gave the more level sections of the State a great advantage in attracting population and developing their agricultural resources. A slow retrogression took place in Overton County and continued for some time. In 1901 the Tennessee Central Railroad built a branch road into the southeastern part of the county to take out coal and timber. In 1906 the Overton County Railroad was built from Algood, in Putnam County, to Livingston, giving the central part of the county an outlet for its products, and as a result the county is once more improving and doubtless will make rapid progress in the future.

Livingston, the county seat, has a population of about 800 and is the social and commercial center of the county. It has two banks and several manufacturing industries, including a flour mill, sawmill, planing mill, spoke factory, stave factory, and spindle factory. Crawford, in the eastern part of the county, on the Tennessee Central Railroad, is a mining town of about 500 people. Several small stations and sidings, which serve as shipping points, are found along both railroads. Monroe, Hilham, and Oakley were at one time towns

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of considerable importance, but now, owing to their lack of shipping facilities, serve only as interior trading points.

The roads of the county as a whole are in a very poor condition, many of the mountain roads having such steep grades and being so rocky as to be almost impassable. The dirt roads of the valleys and the Highland Rim are fairly good during the summer, but in winter are very muddy and become deeply rutted, making travel nearly impossible. Beds of chert and limestone are easily accessible to improve the roads at a relatively low cost. A short piece of macadam road is being constructed at Livingston, and it is probable that this will serve as an example and that the roads will receive more attention in the future.

At the present time lumber and coal are about the only products shipped out of the county, and most of these go to Nashville, which is about 100 miles west of Overton County. Some live stock is also shipped and sold in the Nashville market. The people employed in the lumbering and mining industries within the county furnish a local market for all the agricultural products grown, and will continue to do so for some time.

CLIMATE.

This region has a mild, pleasant climate and seldom experiences extremes of either heat or cold. During the summer months the days are warm, but the nights are always cool. Some snow falls each winter, but never remains on the ground for more than a week.

The table following, giving data in regard to temperature and precipitation, is compiled from the records of the Weather Bureau station at Byrdstown, which is located upon the Highland Rim a short distance northward in the adjoining county. The figures apply to that part of Overton County occupied by the Highland Rim, but for the Cumberland Plateau section, which is about 900 feet higher in elevation, the temperature averages about 3° F. lower than shown by the tables.

The average date of the last killing frost in spring is April 11 and of the first in fall October 20. This gives a growing season of 192 days, or about six and one-half months. The latest recorded frost in spring is April 24 and the earliest in fall September 30. This insures a growing season of nearly five and one-half months free from frost, which is ample time to mature all crops grown in this region. The rainfall during the growing season is sufficient to produce good crops, even in the driest year. It is usually quite evenly distributed. October is the driest month and some difficulty is had in getting wheat properly started.

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Normal monthly, seasonal, and annual temperature and precipitation.

Month.	Temperature.			Precipitation.			
	Mean.	Absolute.		Mean.	Total amount for the driest year.	Total amount for the wettest year.	Snow, average depth.
		Maximum.	Minimum.				
	°F.	°F.	°F.	Inches.	Inches.	Inches.	Inches.
December	38	70	− 9	4.2	5.8	5.5	3.7
January	37	72	− 8	4.3	3.6	6.7	3.9
February	36	73	−19	5.0	6.0	6.6	7.2
Winter	37	.....	.....	13.5	15.4	18.8	14.8
March	49	85	− 1	6.1	2.2	10.4	3.1
April	56	88	24	4.9	3.5	6.1	0.6
May	67	91	34	3.7	3.1	6.4	0.0
Spring	57	.....	.....	14.8	8.8	22.9	3.7
June	73	95	36	4.9	2.3	3.4	0.0
July	76	99	48	4.8	3.7	6.3	0.0
August	75	94	50	4.5	3.2	2.5	0.0
Summer	75	.....	.....	14.2	9.2	12.2	0.0
September	70	96	32	3.2	2.7	3.4	0.0
October	58	89	23	2.2	1.0	1.9	Trace.
November	47	79	11	4.2	2.2	1.6	0.7
Fall	58	.....	.....	9.6	5.9	6.9	0.7
Year	57	99	−19	52.1	39.8	60.8	19.2

AGRICULTURE.

At the time of the first settlements in Overton County transportation was not only difficult, but markets were distant and necessaries had to be hauled over rough mountain roads. In some cases supplies were brought in wagons from Baltimore. Almost as much difficulty was experienced in disposing of the few surplus commodities produced, most of which were loaded in flatboats on the Cumberland River and floated downstream to New Orleans.

These conditions compelled the early settlers to produce nearly everything used by their families. With this end in view they found it necessary to grow a wide variety of crops, including corn, wheat, cotton, hemp, flax, and tobacco. Many kinds of vegetables were also grown in the garden to supply the family table. The cotton, hemp, and flax were worked up into homespun and made into clothing, and little if any of these three crops was included in the flatboat cargoes sent down the river. Some sheep were kept to produce the wool needed for local use.

Cattle and hogs were brought in at an early date and for many years were the principal source from which money was obtained. They were allowed to range at liberty through the forest, receiving little or no attention. In the fall the hogs were collected into large

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droves and driven south into Georgia and Alabama, where they were sold to the cotton planters. The cattle were also taken across the mountains and disposed of in Virginia and North Carolina. For a number of years prior to 1860 mules were raised and taken farther south and sold in the cotton country.

For some time following 1865 conditions remained at a standstill, and in some cases there was an actual retrogression. The practice of driving stock out of the county was discontinued. Manufactured goods could be obtained from outside with greater ease, and the cultivation of hemp and flax was abandoned. The increased price of cotton caused that crop to be grown for market for a few years, but the cultivation of this crop ceased after 1870. Tobacco continued to be a profitable crop for a few years longer. Declining prices from 1876 to 1880 caused it to be discontinued as a commercial crop and it has not been cultivated for the market since. A few patches of cotton, a fourth of an acre or less in extent, are still grown for home needs, and many farmers cultivate a little tobacco for their own use.

Since 1890 there has been a gradual upward trend. Farmers are giving more attention to the cultivation of their crops and the care of their land. Formerly the old bull-tongue plow served the threefold duty of plow, harrow, and cultivator. At the present time the turning plow is in general use, and many have disk and other modern harrows. The double-shovel cultivator is in general use, and some are using the more modern five and seven tooth iron-frame cultivators. In the more level portion of the county the binder has largely replaced the old grain cradle.

Corn is the principal crop produced in the county, the acreage planted to it being fully twice that of all other crops. It is grown in all parts of the county and upon all of the types of soil with varying success. The difference in size and color of the growing crop as observed on the light soil of the Cumberland Plateau and the rich Hagerstown stony loam is very striking, the latter soil being capable of producing at least three times as much grain. According to the Twelfth Census 34,449 acres were planted to this crop in 1899, producing 469,780 bushels, or an average of 13.6 bushels per acre. Wheat is the second crop in importance, but with acreage far below that of corn. The census gives the total as 5,662 acres, with a yield of 29,410 bushels, or 5.2 bushels per acre. The cultivation of wheat is confined almost entirely to the Decatur loam and the Clarksville silt loam. Oats are third in importance, with a total acreage of 3,713 acres, and a yield of 28,780 bushels, or 7.7 bushels per acre.

The authority just cited gives 3,671 acres as the area in clover, millet, other tame grasses, and small grains cut for hay, and the yield of 3,202 tons, or a little less than 1 ton per acre; an acreage of 237

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acres as planted in potatoes, producing 51.7 bushels per acre, or a total yield of 12,264 bushels; 326 acres in sweet potatoes, with a yield of 74.1 bushels per acre, or a total of 24,171 bushels, and 658 acres as devoted to miscellaneous vegetables, the crop having a value of $25,118. The last three items considered were confined to gardens and small plats, the crop being intended for home use. The value of orchard products, nearly all apples, according to the same authority, was $26,639.

There are 235,615 acres included in the farms of Overton County. Of this 99,414 acres, or 42 per cent, is improved. The total number of acres in crops was 49,488 acres, or slightly less than one-half the area reported as improved land. Of the improved land not under cultivation a small portion is used for pasture, but the most of it is allowed to lie idle and grow up to weeds and briers. After lying fallow for one or two years, it is again brought under cultivation and other fields allowed to rest. Most of the land reported as unimproved was covered with a fine growth of timber. The value of the forest products for 1900 was $63,483. Since 1900 lumbering has become the most important industry in the county, and the output of forest products has greatly increased. There has also been considerable improvement along other lines, but the census data will serve as an index of general conditions.

Not much live stock is kept. Most farmers have one or two cows, and a few steers and beef cattle are sold each year, but the annual shipments from the county will not exceed five carloads. The number of hogs slaughtered is quite large, but the pork is all used in the county. A few mules are sold in outside markets.

The adaptation of soils to different crops is recognized to some extent. Wheat is confined to the limestone soils and most of the apple orchards are located on either the Clarksville stony loam or the Dekalb stony loam. The importance of crop rotation is not well understood, and many cultivate a field continuously in the same crop for two or three years, allowing it to grow up in weeds for several seasons after that. Fortunately Japan clover has become thoroughly established in the county, and where a field is left uncultivated the clover takes possession of it, and the result is much the same as though the field had been planted in some cultivated leguminous crop. A few follow wheat with cowpeas the same season, using the vines as hay. Others plant the cowpeas in corn at the last cultivation and harvest the seed. The value of this crop is not generally recognized and its cultivation is limited.

The farm methods practiced throughout the county are quite variable. Preparing the land for corn is done in the spring, the ground being usually broken from 3 to 5 inches deep and harrowed once or twice before planting. Very few put manure on the land

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and the use of fertilizers is not general. Wheat is usually sown in October, either upon land prepared in August and September or following corn.

Most of the farm labor is performed by the farmer and his family. A few, however, hire hands for three to five months each year, paying from $15 to $20 a month with board. Others hire day labor for a short time during the busy season, paying on the average 75 cents a day. Efficient help may usually be secured.

The greater number of the farms are operated by the owners. Where land is rented the tenant usually furnishes everything and receives two-thirds of the crop.

The farms vary greatly in size, the average holding, according to the census of 1900, containing 106.4 acres. The average value at that time, including improvements, was $5.42 an acre. Land values range now from $3 to $25 an acre. The Decatur loam and the Clarksville silt loam, depending upon position and improvements, are worth from $5 to $25 an acre. The stony loam areas can be purchased for $3 to $15, while some of the Dekalb soils in the eastern part of the county sell as high as $50 an acre. This is due to the presence of coal and timber, and it would be hard to determine their agricultural value.

The greatest agricultural need of the county is better preparation and cultivation of the soils. The depth of plowing should be increased to 8 or 10 inches, and after plowing the ground should be thoroughly worked with a harrow to give a mellow seed bed. With corn and other intertillage crops the cultivation should be shallow and frequent and should be continued where practicable throughout the growth of the crop. A small-tooth cultivator should be used in order to keep the surface of the soil as nearly level as possible and to avoid cutting the roots of the growing plant. Where such crops are planted on hilly land the rows should be made to follow the contour of the hill. This would prevent to some extent the washing that now results from water flowing down hill in the furrows. As much organic matter as possible should be worked into the soil, and with this end in view all manure should be carefully saved and cowpeas or other green crops should be grown and plowed under at frequent intervals. Most of the soils in the county would be improved by applying lime at the rate of 2,000 pounds an acre every five years.

The rotation of crops should receive more attention. Each farmer should grow the crops best suited to his needs, but every rotation should contain a cultivated crop, a hay crop, and pasture. In this region legumes, grass, and pasture should occupy the land three years out of five. The following rotation is one of several which will be found adapted to this section: First year, corn followed by

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winter oats; second year, harvest oats and sow cowpeas, in fall sow wheat and seed with red clover, orchard grass, and redtop; third year, harvest the wheat crop; fourth and fifth years, use for hay and pasture.

Cowpeas form a crop which is grown only to a limited extent at present, but its use should become general because of the great value of the crop as a stock feed and the beneficial effect it has on the land. The soy bean is another leguminous crop little known here, but one having an equal value with cowpeas and making a larger yield per acre. Cantaloupes, strawberries, and other truck crops can be grown successfully on the Decatur loam and the Clarksville silt loam, and with better market facilities will prove valuable additions to the present products grown in the county. There are many apple orchards at present on the different stony loam soils of the county. The trees yield well, but most of them are seedlings or inferior varieties. These should be top-grafted and in five years they will be producing profitable crops. There are many advantageous locations for setting out apple orchards in the county. Grapes can also be produced successfully, but the stony soils, where not in orchards or vineyards, should be kept in pasture or allowed to reforest. Stock raising on such land will prove more profitable than any system of cropping. The more rugged and broken hills and mountain sides should be left in permanent forest. The return that can be obtained from time to time by cutting the new growth of timber will be greater than would be realized from the land under cultivation.

SOILS.

Overton County lies within the Appalachian province, and embraces portions of two of its physiographic divisions—the Cumberland Plateau and the Highland Rim. The rocks are sedimentary in origin and consist of sandstones, shales, and limestones, and the geological formations represented extend from the lower Silurian to near the close of Carboniferous time.[a] These rocks lie in nearly level beds, having a slight dip to the southeast. The mountainous topography found over a large part of the county is the result of erosion. The streams during a long period of time have cut deep, narrow, steep-sided valleys, leaving only the tops of narrow ridges to show where a broad, nearly level plain once existed.

The soils found here, with the exception of the bottom lands, which have a very limited development, consist of residual material, resulting from the decomposition and disintegration of the underlying rocks. Most of the geological formations present quite distinct characteristics, and the soils derived from them show an equal dis-

[a] For a detailed discussion of the geology of this region see Geologic Atlas No. 53, U. S. Geological Survey.

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tinctness, so that the boundaries of the different types of soil agree closely with the boundaries of the formations from which they are formed. On the steep mountain slopes, however, there has been a downward or creeping movement of the soil mass, causing the material derived from several different formations to blend together and assume a nearly uniform character over the entire slope. The Highland Rim and the valleys which intersect it are occupied mainly by limestone formations, some of which contain a great deal of chert and siliceous impurities. These have given rise to gray and red silty soils. The gray soils have been included in the Clarksville series, and the red soils in the Decatur series.

The formations exposed on the Cumberland Plateau and its escarpment consist of sandstone and shale. These give rise to soils having a nearly uniform gray color and characterized by a greater percentage of sand than is found in the soils of the Highland Rim. Three types were mapped here, all belonging to the Dekalb series. At the bottom of the deep, narrow valleys in the northwestern part of the county a brown, silty, stony loam has been formed. This type is a result of the weathering of Silurian limestone, and belongs in the Hagerstown series.

Some of the streams have built up narrow bottoms of alluvial material along their courses. These bottoms are limited in extent, while the texture of the soil is quite variable. They have therefore been mapped under the general name Meadow.

The following table gives the name and area of each of the soil types found in the county. Their distribution is shown by means of colors in the accompanying map.

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Clarksville silt loam	78,272	28.2	Decatur loam	11,584	4.2
Dekalb stony loam	67,840	24.5	Meadow	4,672	1.7
Clarksville stony loam	51,008	18.3	Hagerstown stony loam	1,344	.5
Dekalb silt loam	17,984	6.5	Guthrie silt loam	256	.1
Decatur stony loam	17,600	6.3	Total	277,312	.....
Dekalb sandy loam	13,824	5.0			
Rough stony land	12,928	4.7			

HAGERSTOWN STONY LOAM.

The Hagerstown stony loam consists of 8 to 12 inches of heavy brown silty loam, resting upon a subsoil of light-brown to brownish-yellow or yellow clay loam, which grades into a heavy clay at a depth of 18 to 24 inches. Both soil and subsoil contain rock fragments in varying quantities, and the surface is strewn with loose rock and bowlders, while there are frequent outcrops of the underlying massive

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brown and blue limestone. In many cases these outcrops are extensive enough to be separated and mapped as Rough stony land.

This type of soil is found in the northwestern part of the county, at the bottom of the deep, narrow valleys of Mitchell and Mill creeks and their tributaries. It occupies the lower slopes of these valleys, the surface sometimes being so steep that plowing is impracticable. This condition causes it to wash easily, and the soil is badly damaged by erosion where it is not carefully protected.

The Hagerstown stony loam is a residual soil derived from the decomposition of the Normandy limestone of Silurian age. Its stony character is the result of position, which is so steep that much of the fine earth is removed as fast as it is weathered, leaving behind an accumulation of unweathered rock fragments.

Originally this soil was covered with a forest growth of oak, hickory, and other hardwoods, but most of it has been cleared and is under cultivation at the present time, for it is a strong, productive soil and valuable despite the difficulty of working it. Corn, the principal crop, gives yields ranging from 25 to 50 bushels per acre.

CLARKSVILLE STONY LOAM.

The Clarksville stony loam consists of a gray to light-yellow or light-brown silty loam, 8 to 10 inches deep, underlain by a yellow to reddish-yellow silt loam. From 20 to 40 per cent of angular chert fragments, varying from a fraction of an inch to 8 or 10 inches in diameter, are incorporated in the soil and strewn upon the surface. The quantity of such cherty material increases in the subsoil with depth, and the material finally passes into a mass of broken rock. Sometimes this condition is encountered at a depth of 2 feet, but usually the change is more gradual and some fine interstitial material persists to depths of 4 to 10 feet.

The greater part of the Clarksville stony loam is found in the northern part of the county. Narrow strips occur along the valleys of the West Fork of Obey River, Roaring River, and Spring Creek, in the central and southern parts of the county. Other areas are found at the base of the mountains east and northeast of Netherland, and near the bottom of Sinking Cane and other large limestone sinks in the southern part of the county. This type of soil occupies rough, broken hills and steep valley slopes.

The stony character of the Clarksville stony loam makes it more porous than most soils of similar texture, and at the same time the rock fragments scattered over the surface retard the movement of the water to some extent, so that it does not suffer as much from erosion as many soils occupying a like position.

This is a residual soil derived for the most part, through decomposition and disintegration, from the Waverly formation of Car-

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boniferous age. This formation consists largely of a cherty, impure limestone. Some of the higher lying areas are probably derived from cherty material at the base of the Newman limestone.

A large part of this type of soil is still covered with forests of oak, poplar, hickory, beech, maple, elm, chestnut, and ash. That portion under cultivation is planted largely to corn, which produces from 15 to 30 bushels per acre. Wheat and oats are grown to a less extent. A few apple orchards have been planted on the type and the trees have made a fine growth. Clover, redtop, and other grasses can be grown with success, and it is probable that the greatest opportunity open to owners of this soil lies along the lines of stock raising and apple culture. The more broken areas can not be cultivated successfully and should be kept in permanent forest.

CLARKSVILLE SILT LOAM.

The soil of the Clarksville silt loam consists of a gray to light-yellow silt loam, varying in depth from 8 to 12 inches. When dry the surface material has a soft flourlike feel; when wet it is easily puddled and becomes almost as impervious as clay. The subsoil, where typically developed, is a compact yellow silt loam. It usually extends to a depth of 3 feet or more, and is somewhat heavier than the surface soil. In some instances the color changes at 18 to 30 inches to a reddish brown and then grades slowly into a red silty clay. The type for the most part is free from stone, but occasional small areas occur where some chert is found in both soil and subsoil.

The Clarksville silt loam is one of the most extensive types of soil found in Overton County. It occurs in a large continuous area in the western and southwestern parts of the county and again in the northeastern part on the table-land on both sides of Eagle Creek, the two areas being separated by the mountains which form the divide between Eagle and Nettlecarrier creeks on the east and Spring Creek and Roaring River on the west. Small areas occur on the tops of ridges in the northwest part of the county and in the valley of the West Fork of Obey River in the eastern and southeastern part of the county.

Areas of this soil usually occupy level to rolling country occurring at elevations of 900 to 1,000 feet above sea level. In the western part of the county, however, the surface often becomes hilly and broken without developing any stony areas. In this respect the soil here differs from the type as found in other areas previously mapped in the State, where any marked relief of surface gives rise to the Clarksville stony loam. The natural drainage is usually sufficient to carry off the surplus water over the greater portion of the type. A few of the larger areas, however, are so flat that water flows away very slowly, and it is usually late in the spring before the soil is dry

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enough to work well. Such areas may be improved by artificial drainage, either by means of open ditches or tile drains.

The Clarksville silt loam is a residual soil derived from the weathering of the Waverly formation. The more soluble part of the rock has gradually passed into solution and been carried away in the drainage waters, leaving behind the siliceous residue to form the present soil.

Originally a forest growth consisting of white oak, post oak, red oak, hickory, black gum, sweet gum, chestnut, persimmon, dogwood, and poplar covered the Clarksville silt loam areas and there are still large areas in forest. A considerable extent has been cleared, however, and probably one-half the improved land of the county is of this type of soil. Mixed farming is the usual practice. Corn is the principal crop and yields from 15 to 25 bushels per acre. Wheat is second in importance, the yields ranging from 8 to 12 bushels per acre. There is a moderate acreage in oats, of which the yields range from 15 to 25 bushels per acre. Sorghum, cowpeas, and some of the grasses are grown to a limited extent.

Though only moderately productive, this soil, owing to its favorable position and the ease with which it may be cultivated, is one of the most desirable soils for farming in the county. It produces excellent vegetables and small fruits and in some sections of the State cantaloupes and strawberries of exceptionally fine quality. The soil is usually slightly acid in reaction, and is deficient in organic matter. Lime should be applied to neutralize the acidity, and special care should be taken to return all manure to the land and to plow under cowpeas and other green manuring crops. The soil is very easily compacted, and deep plowing is necessary to maintain it in the friable, open condition best for growing plants. Subsoiling once in three or four years would be found beneficial. Where fertilizers are used acid phosphate is found more profitable than a complete fertilizer.

The following table gives the results of mechanical analyses of the soil and subsoil of the Clarksville silt loam:

Mechanical analyses of Clarksville silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19129	Soil	0.6	1.3	1.5	17.9	10.4	54.0	13.6
19130	Subsoil	.4	1.1	1.3	14.6	9.1	41.2	31.7

DECATUR LOAM.

The Decatur loam where typically developed consists of a dark-brown to reddish-brown or red silty loam 8 to 12 inches deep, resting

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on a subsoil of reddish-brown to red silty loam which grades into a dark-red silty clay at a depth of 24 inches. Several areas, however, were encountered where the first 6 to 8 inches of soil is gray to brown, though below that depth the typical Decatur subsoil is found. Such areas were mapped with this type rather than with the Clarksville silt loam. The two soils are usually associated with each other, and the transition from one to the other generally extends over a wide strip, resulting in the variation just described. The soil is usually free from stone, but in a few instances chert is found in both soil and subsoil.

The Decatur loam in Overton County is found in a number of small areas scattered over a strip of country extending across the county from northeast to southwest. It reaches its greatest development around Livingston and Oak Hill in the southern part of the county.

Limestone sinks are common in the areas of the Decatur loam, the surface of which in general varies from hilly—the hills being low and rounded—to nearly level. Naturally the type is well-drained; at the same time the texture is such that sufficient moisture is retained to produce good crops in average seasons. Most of the sink holes have openings in the bottom through which the surface water drains away. In some cases, however, these openings have been closed and ponds are formed.

The Decatur loam is derived largely from the basal rocks of the Newman limestone and to some extent also from the upper strata of the Waverly formation, which underlies the limestone and which is more largely the source of the material forming the Clarksville silt loam. The rocks of these two formations consist chiefly of shales and cherty limestones. The two types of soil are usually intimately associated and are in places apparently derived from the same formation.

The timber growth on this soil is much the same as found on the Clarksville silt loam. The method of farming and crops grown are the same as with the latter type, but the Decatur loam is a stronger, more productive soil. It is better for grass and is used more for hay and pasture than is the Clarksville silt loam. What has been said about special crops for the Clarksville silt loam and the methods of handling that type apply in a general way to this soil as well. The finest Rockyford cantaloupes produced in the State have been grown on farms marking the line of transition from one of these soil types to the other.

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The following table gives the results of mechanical analyses of the soil and subsoil of the Decatur loam:

Mechanical analyses of Decatur loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19137	Soil	0.4	1.7	3.2	22.9	12.1	42.0	17.6
19138	Subsoil	.2	1.1	1.5	16.4	10.3	40.5	29.2

DECATUR STONY LOAM.

The Decatur stony loam consists of a heavy reddish-brown to red silty loam, underlain by a red clay which becomes decidedly heavier in the lower depths. Fragments and irregular blocks of massive blue limestone occur in the soil and subsoil and scattered over the surface. Bed rock is frequently exposed and in many cases the rock outcrop is so general and the quantity of loose rock so great that it was necessary to map such areas as rough stony land.

Areas of the Decatur stony loam are found in the northern, central, and south-central parts of the county. It occupies the sides and tops of rough, rugged hills and occurs as bands extending along the steep slopes at the foot of the mountains. It results from the weathering of the lower member of the Newman limestone. On the steep slopes much of the fine earth has been removed by wash, exposing the underlying bed rock or causing an accumulation of limestone fragments and bowlders on the surface, and this gives rise to the extremely stony character of the type.

The Decatur stony loam was originally covered with a heavy growth of timber, consisting of oak, hickory, black walnut, chestnut, and poplar. It is a strong, productive soil, but on account of its rough, stony character much of it has been allowed to remain in forest. Corn is the principal crop and produces from 20 to 35 bushels per acre. Grass does well and the land makes good pasture.

GUTHRIE SILT LOAM.

The Guthrie silt loam consists of an ash-gray to grayish-white silt loam, 7 to 10 inches deep, resting on a subsoil of about the same color as the soil, but containing more clay. Usually at a depth of 20 to 30 inches the material becomes mottled and stained with yellow iron rust, and small lime concretions appear. When wet the soil is quite sticky and plastic, but upon becoming dry it readily crumbles into a fine flourlike material.

In Overton County this type has a limited development, being confined to a few small areas near Livingston in the central part and

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in the southern part of the county. It is found in low, level areas and basinlike depressions having little or no drainage. It is for the most part a residual soil derived from the underlying limestone, but it is probable that a small part of the material has been washed from surrounding areas of Clarksville silt loam and Decatur loam. Owing to lack of drainage there has been less oxidation than in the higher lying soils; hence the light color of the soil.

Most of the large timber has been cut and the areas are now covered with a growth of bushes and wild grasses which afford some pasture. The soil is largely in a swampy or semiswampy condition and no attempt is made to cultivate it. By underdrainage, however, and by using heavy applications of lime it could be made fairly productive, though it is doubtful if the expense would be warranted while the present land values exist.

DEKALB SILT LOAM.

The Dekalb silt loam consists of 8 to 12 inches of gray to grayish-yellow silt loam, containing a small amount of the finer grades of sand, resting upon a light-yellow subsoil of like texture but of more compact and impervious structure. In some cases the color of the subsoil changes to a brownish or yellowish hue, resembling the color of the underlying rock from which the type is derived.

This is an important Cumberland Plateau soil. It occupies large irregular areas scattered over a strip of country, several miles in width, which extends across the center of the county north and south. Most of the areas occur at a nearly uniform elevation above sea level, about 1,300 feet, though in the eastern part of the county there are two areas lying 400 to 500 feet higher. The soil owes its origin largely to the disintegration of a fine-grained brownish or yellowish sandstone which occurs as a lentil in the Newman limestone. It seems probable that the soil has been somewhat influenced by the decomposition of a thin bed of shale associated with the sandstone. The weathering of the sandstone has been rather slow and uniform, with the result that the soil occurs as broad nearly level areas on the tops of isolated hills and the long spurs reaching out from the western slope of the Cumberland Mountains. It is also found in well-defined terraces, from one-eighth to one-fourth mile in width, about halfway up the face of the Cumberland escarpment.

While this type of soil occupies an elevated position, the surface is so nearly level that drainage water flows away very slowly and in many cases artificial drainage would be beneficial. In some of the larger areas, spots several acres in extent are found where a semiswampy condition prevails. In a few places sink holes are found. These have been formed through the falling of the roofs of caverns

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in the underlying massive limestone, the superimposed sandstone strata being too thin to bear the strain.

The native growth found on the Dekalb silt loam consists of oak, chestnut, chinquapin, ash, hickory, poplar, and dogwood. The soil is not as productive as some of the other types, but owing to its level surface and the ease with which it can be cultivated many have improved it, and nearly half of it is at present under cultivation. Corn, wheat, oats, sorghum, and other crops are grown. Corn produces 15 to 20 bushels per acre, and wheat 6 to 10 bushels per acre. The soil is noticeably low in organic matter, and special care should be taken to supply this deficiency by plowing under green crops and manure. The mineral fertilizers, potash and phosphorus, would be found beneficial. A fine quality of Irish potatoes can be produced on this soil and peaches do well. These two products and small fruits should be the most profitable crops on the type.

The following table gives the results of mechanical analyses of the soil and subsoil:

Mechanical analyses of Dekalb silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19147	Soil	0.2	1.1	0.4	16.1	9.6	57.9	13.9
19148	Subsoil	.2	.5	.3	10.3	11.7	55.2	21.1

DEKALB STONY LOAM.

The surface soil of the Dekalb stony loam is a gray to light-yellow medium to fine sandy loam containing a considerable quantity of sandstone and other rock fragment. The subsoil is somewhat variable, the greatest portion of it, however, consisting of a yellow fine sandy loam or loam. In some cases it ranges from a heavy yellow loam to clay loam or clay. These differences are due to the variations in the rock from which the type is derived.

In the southeastern quarter of the county this is the prevailing type of soil. It also occurs as a narrow band occupying the upper slopes of the mountains which extend out into the central and northwestern part of the county. This band occurs just below the Dekalb silt loam which caps these outliers. The Dekalb stony loam occupies the steep rugged mountain slopes having an altitude ranging from 1,000 to 2,000 feet. The water falling upon these steep surfaces flows swiftly away, carrying a large quantity of the finer soil particles with it. If it were not for the protection afforded by the heavy forest which covers most of these mountains, much of the surface

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soil would be quickly washed away, leaving the region in a badly eroded condition.

The Dekalb stony loam has been produced by the weathering of Carboniferous rocks, including all of the formations found in this county above the lower member of the Newman limestone. These are for the most part sandstone and sandy shales, but a few bands of clayey shale are found. Seams of coal are interbedded with the other material, but have no influence on the soil. The higher lying formations are sandstone and the material derived from their disintegration has crept down over the steep slopes, mixing with other material and giving the soil a uniform character over the entire slope. The subsoil comes direct from the underlying formation and is therefore more variable, the sandstone giving rise to a sandy loam to loam, while the material from the shale and limestone varies from a heavy loam to clay. The weathering has been by no means complete, and a large quantity of rock fragment is found in both soil and subsoil and scattered over the surface. The sandstone frequently stands in cliffs, below which large blocks of rock cover the ground. The limestone also has resisted weathering to a considerable extent, and in many places the surface is covered with outcrops and large bowlders of this material. The larger areas of this character have been mapped as rough stony land, but many too small to be shown on the map were included in the Dekalb stony loam.

These mountain slopes were at one time all covered with a heavy growth of timber consisting of oak, hickory, chestnut, and poplar. A few small areas have been improved and much of the type is being rapidly deforested by lumber companies. Corn and a few vegetables are about the only crops that have been grown on the cleared areas. The yields of corn are light, from 10 to 20 bushels per acre. A few apple orchards have been set out and the trees make a fine growth and bear quite regularly, showing that in favored locations apples can be grown successfully. Where the heavier subsoil exists grass does well and the land may be used for pasture. By far the greater portion of the soil, however, is too rough for agricultural use and should be left permanently in forest. The marketable timber obtained from time to time will be far more valuable than any returns that could be obtained by cultivating the land.

DEKALB SANDY LOAM.

The soil of the Dekalb sandy loam is grayish to yellowish in color, varies in texture from a fine sandy loam to heavy sandy loam, and has a depth ranging from 8 to 12 inches. The subsoil is a medium to fine heavy yellow sandy loam which frequently grades into a loam. The sandstone from which it is derived is usually encountered at a

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depth of 4 to 12 feet, and when the surface is sloping it is sometimes exposed as an outcrop. The soil for the most part is free from stone, but blocks of sandstone are occasionally scattered over the surface.

The Dekalb sandy loam is found in the eastern and southeastern parts of the county and occupies the tops of high mountain ridges—outliers of the Cumberland Plateau. The surface features vary from level to gently rolling, but its position at the top of the mountain and the relatively light texture of the soil insure ample drainage. At the same time little damage is done by erosion. The soil is not retentive of moisture and crops are inclined to suffer from drought. It is a residual soil derived from the disintegration and breaking down of the Rockcastle conglomerate, a formation consisting largely of massive, cross-bedded gray sandstone with some small white quartz gravel scattered through it. The rock forms cliffs from 10 to 60 feet high at the outer edge of the Dekalb sandy loam.

The same native vegetation is found here as on the Dekalb stony loam, but the growth has not been as vigorous, and the timber is not as large. Most of the soil is still in forest. Where it has been cultivated corn is the principal crop, and yields not exceeding 20 bushels per acre are obtained. The soil is easily worked, and, with the aid of manure and commercial fertilizers, good yields of Irish potatoes, tomatoes, string beans and other truck crops, and small fruits may be obtained. These products would find a ready sale at local markets, which have been created in this region by the development of the large lumbering and mining industries.

The following table gives the results of mechanical analyses of the soil and subsoil of the Dekalb sandy loam:

Mechanical analyses of Dekalb sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19155	Soil	0.4	4.8	17.4	16.5	4.0	37.8	19.0
19156	Subsoil	.4	5.6	18.8	16.5	4.2	33.4	20.9

ROUGH STONY LAND.

In Overton County the name "Rough stony land" has been applied to areas where there is sufficient rocky material at the surface, either in the form of rock outcrop or as bowlders and rock fragments, to prevent the use of the land for any agricultural purpose other than pasture. Such areas are developed in varying degrees in connection with all the stony loam types. The larger areas are all shown in the map, but there are many smaller ones scattered through the stony loam soils that are too small to be indicated.

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The most extensive Rough stony land areas occur on the steep slopes of the deep, narrow creek valleys in the northeastern, northern, and western parts of the county. Other areas occur along the sides and at the tops of the lower mountains in the central and southern parts of the county. A few areas are found in the eastern part of the county near the top of the main ridge forming the divide between the east and west forks of Obey River.

Rough stony land is derived principally from the sandstones and cherty limestones. Sometimes where it is derived from limestones there are small patches of dark-colored loam or clay loam which are suitable for cultivation, but such areas are too small to be indicated in the map. Most of the Rough stony land is covered with a heavy growth of timber, but in places where the underlying rocks lie very close to the surface and where the soil is very thin the growth is small and scraggy.

MEADOW.

The name "Meadow" has been applied to the bottom lands found along the creeks and rivers throughout Overton County. These Meadow areas occur as long, narrow, practically level strips sometimes on one side of the stream and sometimes on both sides. They are seldom over one-eighth mile in width and usually much narrower.

In texture the soil is variable. In the western and northwestern parts of the county the material is a rather heavy brown silt loam, while in the central part of the county, where the bottoms are found within the Clarksville silt loam, the soil though silty is lighter in color. In the eastern and northern parts of the county the soil is usually sandy and frequently quite gravelly. Some of the Meadow areas are poorly drained and somewhat swampy.

The Meadow is practically all cleared and under cultivation at the present time, and is usually more productive than the adjoining hill types.

SUMMARY.

Overton County, lying in the north-central part of Tennessee, has an area of about 433 square miles. It includes portions of the Cumberland Plateau and Highland Rim of Tennessee. The surface features vary from broad nearly level areas to mountains; about two-thirds is rough and broken. It is drained by a number of small streams which flow into Cumberland River.

The county was settled about 1800, and organized in 1806. It was for a long time without railroads, but at present there are two short lines giving service to the southern and central sections. Livingston is the county seat with a population of about 800. Other small towns are Crawford, Monroe, Oakley, and Hilham.

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The county has a mild, pleasant climate with little extreme heat or cold. The mean temperature is 57° F. and the average annual rainfall 52.1 inches.

Lumber and coal are the leading products shipped out of the county, and Nashville is the principal market. Corn is the important agricultural product, the acreage being twice that of all other crops. Wheat is second in importance. Other crops are oats, clover, millet, and other grasses for hay. Potatoes, garden vegetables, and fruit are grown to a limited extent. But little live stock is kept.

The farmers do most of their own work. Farm labor may be had at 75 cents a day or from $15 to $20 a month. Most of the farms are operated by their owners. Agricultural land ranges in value from $3 to $25 an acre.

With the exception of a limited amount of bottom land the soil of the county consists of residual material formed by the weathering of the underlying rock. The boundaries of most of the types agree closely with the outline of the formation from which they are derived, and eleven types of soil were recognized and mapped.

The greatest need of the county is better preparation and cultivation of the land. Most of the soils would be improved by the use of lime, and rotation should be practiced. Cantaloupes and other truck crops can be grown to advantage on the Decatur and Clarksville soils. Apples and grapes would be profitable on the stony loams.

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SOIL SURVEY OF COFFEE COUNTY, TENNESSEE

By W. E. McLENDON and C. R. ZAPPONE, Jr.

DESCRIPTION OF THE AREA.

Coffee County, with an area of 282,240 acres, or 441 square miles, is situated near the center of Tennessee, between parallels 35° 15′ and 35° 40′ north latitude and meridians 85° 45′ and 86° 20′ west longitude. It is in direct line and about halfway between Nashville and Chattanooga. On the north it is bounded by the counties of Cannon and Warren, on the east by Warren and Grundy, on the south by Franklin and Moore, and on the west by Moore and Bedford counties.

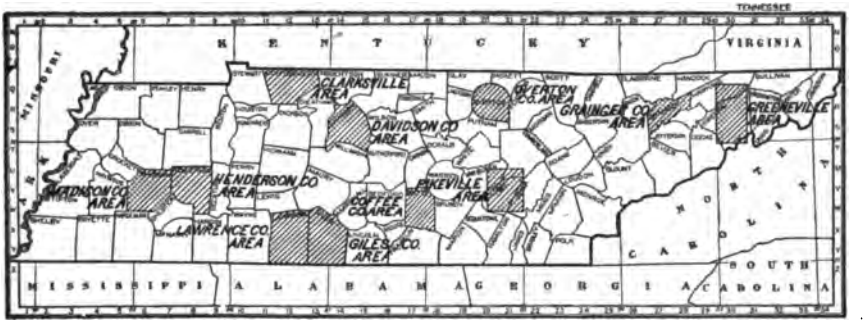

FIG. 27.—Sketch map showing location of the Coffee County area, Tennessee.

Most of the county is in Highland Rim, which is a level to brcken narrow plateau, occupying an intermediate position between the Cumberland Plateau on the east and the Central Basin or limestone valley section on the west. The Cumberland Plateau overlooks the Rim in a rough mountainous escarpment from 800 to 1,000 feet high and the Rim in turn becomes very broken in its outer portion and gives way finally to the much lower limestone lands. The narrow strip of the Cumberland escarpment extending along the eastern boundary is very rough and stony and has no value except for the timber it supports. Bordering the mountains is a belt of rolling limestone lands which are highly prized for agricultural purposes. Then comes the extensive level to gently rolling region, known as

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the "Barrens," which occupy at least three-fourths of the county, in a continuous belt from the Moore and Franklin county line on the south to the Cannon and Warren line on the north. Throughout this region the streams are few and have only shallow valleys with little or no bottom lands. Vast areas are nearly level, but generally there is enough surface relief to provide good natural drainage. The western edge of the county is mostly very rolling and broken. Streams are numerous and in their rapid descent to the lowlands have carved out an intricate system of deep valleys and tortuous ridges with differences in elevation of 100 to 400 feet. As the streams become larger to the west their valleys gradually widen and the ridges give way more and more to lower rolling lands of the same general character as found beyond the Highland Rim. The upper plain of the Rim has a general elevation of 1,000 to 1,100 feet, while the lower part of the valleys is not more than 500 or 600 feet above sea level.

The drainage of a very large proportion of the county is effected through the Duck River and its tributaries. The extreme southern edge and a part of the eastern edge drain to the south into the Elk River, which does not enter the county, but forms about 7 miles of the southern boundary from the southeastern corner and then turns more to the south. Its principal tributaries in the county are Beans and Bradley creeks, which have their headwaters in the mountainous escarpment. The northeast corner and a strip along the northern boundary farther west are drained by the upper tributaries of Barren Fork of the Cumberland River. The Duck River extends well over into the "Barrens," and rises in two prongs. The larger of these rises near the northern boundary and flows in a southerly direction to near the center of the county, just west of Manchester, where it is joined by Little Duck River from the northeast, thence the course is southwesterly and westerly until beyond the western boundary. The principal tributaries on the south side of the river are Carroll Branch and Crumptons Creek, and on the north side Brewers and Rileys creeks and Noah and Garrison forks. The last three are entirely in the rough section of the Outer Rim, but the others, like the prongs of the Duck River, rise back in the "Barrens" and have not developed any abrupt features along their courses, until they begin to make the descent from the Upper Rim, which they do in a number of rapid cascades and falls. The Duck River especially offers opportunities for developing considerable water power.

The territory now included in Coffee County was settled in the early part of the last century simultaneously with other sections of Tennessee. The limestone lands were the first sought after and are now the most extensively developed. The "Barrens," on the other

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hand, which has always been looked upon in an unfavorable light, is still very sparsely settled. The settlers came principally from North Carolina and Virginia, and their descendants constitute the bulk of the present population. Coffee County was organized in 1836 from parts of Franklin, Bedford, and Warren counties. In 1900 its total population was about 16,000.

Tullahoma, the largest town, is situated near the southern edge of the county and has a population of about 3,000. Manchester, the county seat, with about 1,000 inhabitants, is situated in the center of the county near the confluence of the upper prongs of the Duck River. Summitville, 7½ miles northeast of Manchester, has a population of 200 or more. The only other railroad stations are Hickerson and Belmont, between Tullahoma and Manchester. Beechgrove is a small town on the western side, and Hillsboro is another place of about the same size in the east-central part of the county. All of the smaller country post-offices were abandoned after the introduction of the rural free delivery service, which now reaches all parts of the county.

The railroad facilities, though fairly good, are not adequate for the proper development of the county. As the county is bounded on the east by the Cumberland Mountains and on the west by the rough escarpment of the Highland Rim, it is hardly probable, however, that any new railroads will be built. Under the circumstances the best thing to do would be to improve the public roads so that the present stations could be more easily reached. The majority of the roads are in bad repair and receive very little attention. The main line of the Nashville, Chattanooga and St. Louis Railway, which affords quick service to all points north and south, crosses the southwestern corner in a southeast and northwest direction, and in Bedford County it turns more to the north and affords an outlet for the rough areas along the western edge farthest away from Manchester. The Sparta branch runs from Tullahoma and extends out of the county in a northeasterly direction. Decherd, on the main line in Franklin County, is the nearest station to the southeastern corner.

Tullahoma and Manchester are the chief marketing centers, though considerable trade goes to Decherd, in Franklin County, and to Normandy, Wartrace, and Bellbuckle, in Bedford County. Nashville and Chattanooga are the nearest large markets, which from Tullahoma are 69 and 82 miles, respectively. A part of the wheat crop is handled by small mills at Hillsboro, Manchester, and other local towns, the remainder being shipped to Nashville and other points. Cattle and hogs are shipped in carload lots to Nashville and Louisville. Some of the tobacco grown is taken by a factory in Tullahoma. All of the cantaloupes are shipped to outside markets.

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CLIMATE.

The high altitude of the Highland Rim and its proximity to the mountains have quite a modifying influence upon the climatic conditions in the county. The summers are long and warm enough to permit the successful growing of a great diversity of crops. Even during the hottest weather the nights are delightfully cool. The winters are short and generally mild, except for recurring cold snaps. The thermometer sometimes registers below zero. The climatic data given in the table below, compiled from records of the Weather Bureau station at Tullahoma, are especially applicable to the leveler parts of the county. In the Outer Rim, where the topography is very broken, the ridges have at least a small sheltering influence, the effects of the cold north winds are less severe, and the growing season is virtually prolonged by the warding off of some of the light frosts of spring and fall. As a whole the climate is mild, pleasant, and very healthful.

Normal monthly, seasonal, and annual temperature and precipitation at Tullahoma.

Month.	Temperature.			Precipitation.			
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year.	Total amount for the wettest year.	Snow, average depth.
	°F.	°F.	°F.	Inches.	Inches.	Inches.	Inches.
December	39	69	− 5	5.2	2.5	7.2	3.7
January	38	74	−14	5.9	7.0	8.4	3.5
February	40	72	−20	4.6	1.2	9.2	3.4
Winter	39	.....	.....	15.7	10.7	24.8	10.6
March	49	81	0	6.5	3.6	9.8	1.9
April	57	87	22	4.9	5.6	4.7	Trace.
May	67	92	32	2.9	1.6	3.2	0.0
Spring	58	.....	.....	14.3	10.8	17.7	1.9
June	73	97	40	4.1	2.6	4.6	0.0
July	76	100	41	4.9	7.6	10.6	0.0
August	75	98	48	3.8	2.4	2.3	0.0
Summer	75	.....	.....	12.8	12.6	17.5	0.0
September	68	97	27	2.9	3.3	2.2	0.0
October	58	91	22	2.5	3.9	2.4	0.0
November	47	77	13	3.8	2.6	2.0	0.2
Fall	58	.....	.....	9.2	9.8	6.6	0.2
Year	57	100	−20	52.0	43.9	66.6	12.7

The mean annual temperature as shown by the table above is 57° F., the absolute maximum 100° F., and the absolute minimum −20°

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F. July is the hottest and January the coldest month in the year. The annual precipitation averages about 52 inches, but varies from 43.9 to 66.6 inches. In the driest years the precipitation is sufficient to produce maximum crops were it evenly distributed, but droughts occur occasionally and do much damage, and the same is likewise true when there is too much rainfall. The snowfall averages about 12.7 inches a year.

The average date of the last killing frost in the spring is April 18, and of the first in the fall October 16. The growing season is about six months long, or fully a month shorter than through the main cotton belt. The shorter season, coupled with the cool nights prevailing through the summer months, puts the county practically out of the cotton-producing section. Erratic frosts in the spring make some of the fruit crops uncertain, especially peaches and pears, which bloom early.

AGRICULTURE.

The agricultural development of Coffee County has followed very closely the different soils in the order of their desirability for general crops. The first distinction made was between the soils of chert and limestone origin, which are widely different in productiveness, then between the individual types in each of these groups. The "Barrens," or Clarksville silt loam belt, extending over a very large part of the county, together with the Clarksville stony loam, is very scatteringly and irregularly developed, vast tracts not being occupied at all. The majority of the farmers here operate on a small scale and live in an unpretentious way. There are a few, however, who under the same environment own large, well-kept farms with good residences and outbuildings, showing most conclusively that the absence of a greater degree of prosperity is not due altogether to the unproductiveness of the soil, but fully as much to the farm methods generally employed. A striking contrast to this chert region is afforded by the limestone soils, which are naturally productive. The best and most extensive improvements are found on the Hagerstown silt loam and the Decatur clay loam; an intermediate condition is represented by the Hillsboro silt loam and the Elk loam; and after these are the stony loam areas, which, though very productive, can not be farmed to much advantage because of the rough stony character and the steep topography. The alluvial soils are handled in connection with the adjoining uplands and their desirability depends very largely upon their origin.

The early settlers, having for the most part very limited means, resorted to many crude practices, and the absence of markets made it necessary for them to give chief attention to such crops as could be consumed to advantage at home. What one needed perhaps

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another had; so by bartering among themselves it was possible to get along without being in close touch with the outside world. As is often the case in the development of a new section remote from transportation facilities, there was not much attempt at diversification of staple crops, the tendency being to grow the same crops on all of the soils. Corn and wheat were the chief crops. These were supplemented by several other crops grown on a limited scale. In some localities small patches of cotton and flax were grown for the fiber, as most of the clothing and bedding were woven at home. Some kept small herds of sheep, and on nearly every farm were a few cattle and generally enough hogs to provide a supply of meat. The stock had wide range and could be kept at very small cost.

Conditions improved gradually until the beginning of the civil war. While there was no great degree of prosperity, nearly all of the farmers lived free of debt, some being in very comfortable circumstances.

The effects of the war, while less disastrous than in some other sections of the South on account of the comparatively few slaveholders, were severely felt by all classes and brought them face to face with entirely new economic conditions. The crops produced went more and more to market to meet the necessity for ready cash. Otherwise the old system of farming was continued without any radical changes. For many years after the war the farmers found it hard to make ends meet and many went heavily into debt trying to get started again. Within the last fifteen years, however, there have been decided improvements. Nearly all of the mortgage debts have been paid, improved farm machinery is coming more into use every year, and the home surroundings generally indicate more prosperous conditions. Evidences of recent development are seen throughout the "Barrens," where immigrants from the northern States are beginning to settle.

No statistics are available to show the present state of development, but some idea as to the extent and relative importance of the different crops can be had from the figures given in the Twelfth Census. At that time 193,788 acres, or about two-thirds of the total area of the county, were in farms, of which 97,420 acres were improved. Something like one-third of the area reported as improved is used for pasturage. Of the cultivated areas in 1899 there were 31,114 acres in corn, producing 694,110 bushels; 18,848 acres in wheat, producing 156,630 bushels; 1,587 acres in oats, producing 19,650 bushels; and 6,415 acres in grains, grasses, and millets cut for hay, producing 6,513 tons. Besides these crops may be mentioned tobacco, cantaloupes, rye, sorghum, clover, cowpeas, sweet and Irish potatoes, and miscellaneous vegetables. Alfalfa and soy beans have recently been introduced and are beginning to receive.

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attention. Stock raising is an important industry with many of the farmers on the limestone soils, especially in the western part of the county. Fruit is not grown on a commercial scale, but small apple orchards are found on nearly all of the farms and here and there a few pear and peach trees are seen.

According to the Twelfth Census the total value of the live stock was $534,835 and of products not fed to live stock $735,124. The orchard products were valued at $24,082 and the forest products at $31,349. The undeveloped areas still support a great deal of merchantable timber, consisting very largely of oak, but this is rapidly being removed for lumber and cross-ties, both of which command good prices. Vehicle and furniture factories take a large part of the best lumber.

Corn is by far the most extensive crop on all types of soil, even being grown on areas entirely too stony and rough for cultivation. The low average yield of 20 to 25 bushels per acre is due to the fact that a large proportion of the crop is grown on the Clarksville silt loam. Here the yields are invariably light, unless the land has been put in good condition. By applying sufficient quantities of stable manure or practicing a systematic rotation of crops from 30 to 50 bushels can be produced. Yields of 40 to 50 bushels are not uncommon on the limestone soils, as high as 75 bushels per acre having been reported on some of the best upland and alluvial areas. The yields could be considerably increased simply by better preparation of the land and by proper selection of seed. Poor stands and yields are traceable to inferior seed as often as to any other cause.

The cool climate has prevented cotton from becoming one of the staple crops. The cool nights prevailing through the summer months are very unfavorable to its growth, and the seasons are generally too short to allow a full crop of bolls to mature. At the time of the survey a few small patches were seen in the southeastern part of the county. Despite the low yields it is possible that there will be some increase in the acreage of cotton if the prices continue high.

Wheat is the second most important crop on all of the level and moderately rolling uplands. It is not grown to any extent on the Clarksville stony loam or the Hagerstown stony loam, on account of the difficulty in harvesting. Oats have about the same distribution as wheat, but are usually grown in small patches for home consumption. The yields of both crops vary with the character of the soils, from light on the Clarksville silt loam to very good on the Hagerstown silt loam and the Decatur clay loam. Where they follow corn, as is often the case, one method of preparing the land is simply to go over it once or twice with a disk harrow, then the grain is either sown broadcast or in drills. Better results are obtained where the land is given a deep thorough breaking and harrowed to good tilth before

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the planting is done. On the Clarksville silt loam it is getting to be a common practice to drill in with the grain from 100 to 300 pounds of fertilizer to the acre. Not enough care is exercised as to the time of planting. Oats are planted in September and early October and wheat about the 20th of October.

Grass and clover crops are confined very largely to the limestone areas, where they give good results. Cowpeas, while grown in a limited way, have not become an important forage crop with most of the farmers. This crop is adapted to any of the soils and should be grown extensively as a soil improver as well as for hay. On the Clarksville silt loam millet and Hungarian grass are coming into favor as hay crops. The grasses most generally grown are timothy, herd's-grass, and orchard grass, which are excellent for hay, while orchard grass, especially when planted with clover, makes excellent pasturage. Oats and herd's-grass mature very well together and make a good grade of hay. Bermuda grass has not been tried, but would prove a very valuable pasture grass on all of the uplands, including the rough and stony areas. On the Hagers own silt loam and stony loam good pasturage is afforded by Kentucky bluegrass, which is indigenous to these types.

Rye is grown to only a very limited extent. It should become an important crop on the lighter soils. There is a good demand for all of the grain that can be produced, and the crop will prove valuable as a soil improver and at the same time afford good early spring pasturage. Rye should be planted as a cover crop on all of the areas that would otherwise be left bare during the winter months. It could be pastured until just before time for planting other crops, then plowed under for green manure.

Alfalfa is a very promising crop for the Hagerstown silt loam and the Decatur clay loam and can be grown successfully on some of the lighter types if they are put in the best possible condition. This crop does not thrive on an unproductive or a poorly prepared soil; it requires a deep, rich, loamy and well-drained soil, whether of light or heavy texture. If the land is not already very rich, make a heavy application of stable manure, and generally at least a small application of lime will prove beneficial. Plow deep and harrow until all of the clods are crushed, then drill the seed in at the rate of 15 pounds per acre. The planting should be done in August or early September, so that the plants will have time to become well established before the beginning of winter. In case weeds become very bad by early spring, mow as often as is necessary to subdue them. There should not be much trouble from this source after the first cutting, if the stand is good.

Within the last three years the production of dark export tobacco has assumed commercial proportions on the Clarksville silt loam,

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and the acreage is increasing. The results have not been uniformly satisfactory, due largely to the lack of appreciation as to the requirements of the crop. Inferior seed is one cause of light yields or inferior quality. In some cases the soil is not properly prepared and the cultivation is not as thorough as it should be. Some farmers do not use any fertilizers, while others make light applications, without much thought as to whether the kind used is suited to the crop or not. The average yield is about 500 pounds per acre. From 700 to 900 pounds per acre should be secured to make the crop very profitable. The process of curing consists in first thoroughly wilting in the sun, then transferring to sheds and barns to remain without further care until thoroughly cured out.

Growing cantaloupes for market has been started within the last two years and bids fair to become an important industry on the Clarksville silt loam. While the returns have not been altogether satisfactory, the trouble is not inherent in the soil. Light yields and a low-grade melon usually can be traced to one of two causes or to both—poor seed and improper attention. Most of the seed are bought, and some are not even the variety they are supposed to be. A common mistake is not to fertilize the soil well enough; another is in not selecting areas that are in a high state of cultivation. A good application of stable manure, in connection with 400 to 800 pounds of a high-grade fertilizer per acre, will prove very profitable, other conditions being favorable.

A variety of fruits can be grown successfully on a commercial scale in this county. Apples, peaches, pears, cherries, and nearly all of the domestic berry crops do well, yet only apples receive any attention, and these are grown mostly for home use. The varieties of apples most generally grown are the Arkansas Black, Winesap, Limbertwig, Ben Davis, Kinard's Choice, and Smoky Twig. Peaches are rather uncertain on account of late spring frosts. A small nursery just outside of Tullahoma makes a specialty of apple and peach trees. No vegetables are grown for the market except in a small way for the Tullahoma trade. Trucking should become an important industry on the Clarksville silt loam.

The live-stock industry is confined very largely to the raising of hogs and cattle, the latter being mostly of nondescript breeds which do not command the highest market price. The raising of sheep, horses, and mules, which now receives very little attention, should prove profitable wherever good pasturage can be had. While only a few have made the poultry industry a special feature, chickens and eggs in large quantities are shipped during the spring, summer, and fall months, a fast-freight service, generally on Friday of each week, being maintained for this purpose.

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The present system of agriculture, although based largely upon practices extending over a long period of years, has been evolved without much reference to the special adaptation of certain soils to particular crops, the tendency being to grow the same crops on all soils in so far as their productiveness and surface features will permit. There is some evidence, however, that the need of specialization and a greater diversity of crops is beginning to be recognized. The growing of tobacco and cantaloupes, which has been recently started, is confined almost entirely to the Clarksville silt loam. Both of these crops could be extended to the Hillsboro silt loam with equally as good success, and in case of the cantaloupes satisfactory results probably could be obtained on the Elk loam. The heavier limestone soils are peculiarly adapted to grasses and stock raising and are used extensively for this purpose.

No systematic rotation of crops is practiced by a majority of the farmers. A proper rotation affords the easiest and most efficient means of keeping the soils in a productive state and at the same time increases the resources of the farm. As it is, corn is often planted on the same land continuously for several years or alternated with other crops in an irregular rotation. A common practice is to follow corn with wheat or oats. After the grain crop is removed the land is left bare until the following spring, when corn is planted again. A better rotation, covering the same period of time, would be to plant corn the first year and also a crop of cowpeas, which should be plowed under after the corn is harvested; then wheat or oats in the fall and again to cowpeas after the grain is removed, following with corn the next spring. If the pea vines after the grain crop make a heavy growth, they should be mowed for hay; otherwise plow the entire crop under. A rotation that has proved very satisfactory on the lighter soils is to plant to cowpeas the first spring, following with wheat or oats in the fall, again to cowpeas the next summer, then to grass in the fall, which should be allowed to stand for two or three years. If preferred, clover can be substituted for the grass, or if neither of these is to be included, corn the third year, planting rye as a cover crop the previous winter. Light applications of lime will prove beneficial after heavy crops of cowpeas or rye are plowed under. Areas for tobacco should be in a good state of cultivation, but it is rarely advisable to plant this crop after a heavy growth of cowpeas, as it will have a tendency to grow too long and not to ripen properly.

Commercial fertilizers are used extensively on the soils of chert and siliceous limestone origin, where the yields are generally unsatisfactory. In 1900 the expenditures for this purpose amounted to $20,060, and now considerably more is being used in connection with the tobacco and cantaloupe crops. The soils respond to a greater or

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less degree to any fertilizer, but their manurial requirements for the different crops have not been determined. As a result the increased returns by the use of fertilizers often do not always justify the extra expense, this being especially true with reference to wheat, oats, and corn.

Labor is scarce. The small number of negroes live mostly in or near Tullahoma and Manchester, where they find other employment than on the farms. The scarcity of labor does not affect the farmers operating on a small scale, as they depend upon their families for the necessary help, but on the large farms it is quite different. Day laborers receive from 60 to 75 cents a day and regular help from $13 to $18 a month, with a house, but without board.

According to the Twelfth Census the average size of farms is about 100 acres. Some of the tenant farms are less than 50 acres, while some of the larger estates have over 1,000 acres. About 56 per cent of the farms are operated by the owners, a few by managers or overseers, and the remainder by tenants.

The general plan of renting is for a certain portion of the crop. If the owner furnishes the work stock, tools, and seed, in addition to the land, he usually gets two-thirds of the crop; if he furnishes only the land and house he gets one-third; by paying one-half of the fertilizer bill, as is sometimes done, he receives one-half of the crop. Very little land is rented for cash.

Taken as a whole, land values in the county are still rather low. The best uplands around Beechgrove range from $40 to $60 an acre, and some of the choicest bottom lands through this section can not be bought for less than $75 an acre. The red limestone lands around Hillsboro range from $30 to $60 an acre. Through the "Barrens" the price ranges from $5 to $20 an acre, depending upon the amount of timber standing, the surface features, improvements, and nearness to town or shipping point.

SOILS.

The soils of Coffee County are representative of the Highland Rim, and have extensive development elsewhere through the central and western divisions of the great Appalachian province extending from Pennsylvania to Alabama. They fall naturally into two general groups, namely, residual and alluvial. The residual or upland soils have been formed in place by the decay and disintegration of the underlying rocks, which consist of the Fort Payne chert and the Chickamauga and Bangor limestones; they vary directly with the different formations and conditions in the topography, as well as with different phases of the rock formation. The alluvial soils, which are very limited in extent, consist of material transported from the uplands by the streams and laid down in their flood plains.

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The formations underlying the county occur almost horizontally as originally laid down. As a result, only a few of them reach the surface, and these at different elevations. The Fort Payne chert areas and the term "Barrens" are almost synonymous. Besides extending almost uninterruptedly over all of the leveler sections of the county, the Fort Payne chert caps all of the ridges and higher outlying knolls along the western boundary. In all of the deeper valleys of the Outer Rim a thin band of the Chattanooga black shale reaches the surface immediately below the Fort Payne chert, but it is of no agricultural consequence. Below this is the Chickamauga limestone, which extends on down the slopes and across the lower lying areas, even reaching to the top of some of the lower ridges. The northwestern corner of the county is practically in the central basin, where the Chickamauga limestone is about the only surface formation. Along the inner portion of the Rim the chert is overlain by the Bangor limestone, the two in many places grading almost imperceptibly into each other. The rough, mountainous escarpment projecting into the county is also of the Bangor limestone and small, detached areas are found farther west through the "Barrens" proper. At Summitville is quite a pronounced knob of it which is being used for ballasting purposes and for making lime and cement.

The Fort Payne chert formation consists of very siliceous limestones and fossiliferous and flinty cherts more or less closely interbedded. The calcareous layers give way more and more to chert with depth. The Chickamauga limestone is a blue, massive to flaggy limestone carrying a rather large proportion of argillaceous material. The Bangor limestone is the most variable of the formations. Although consisting very largely of a blue massive limestone, the lower layers are chiefly of a siliceous character and carry a considerable percentage of fossiliferous chert.

The Chickamauga limestone gives rise to two types of soil, members of the Hagerstown series, and to small areas of Rough stony land. The leveler areas, with little or no stone in the soil, constitute the Hagerstown silt loam. The rougher areas, which are quite stony, but can be cultivated or developed into good pasture lands, were mapped as the Hagerstown stony loam. The Hillsboro silt loam is from the siliceous phases of the Bangor limestone. The massive phase out of the mountains gives the Decatur clay loam. The mountainous areas were mapped as Rough stony land. Two members of the Clarksville series are derived from the Fort Payne chert, the silt loam, including all of the leveler areas with medium to good drainage, and the stony loam, including the rolling and rough areas, where both the soil and subsoil are very stony. The poorly drained areas through the Clarksville silt loam were mapped as the Guthrie silt loam. The only other upland type is found in the

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eastern part of the county, occupying what appears to be old terraces or abandoned valleys. Their position and general characteristics are such as to lead to the belief that the soils are partly residual from phases of the Bangor limestone and partly old alluvial deposits. Being of the same general character they were mapped as one type—the Elk loam.

The alluvial lands vary locally and also in a general way with the different geological formations through which the streams flow. The bottom lands through the limestone areas were mapped as the Huntington silty clay, and those where the drainage is entirely from the Fort Payne chert were mapped as the Holly loam.

Including Rough stony land, eleven types of soil were recognized and mapped. Their names and extent are given in the following table:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Clarksville silt loam	182,784	64.8	Elk loam	6,144	2.2
Clarksville stony loam	28,416	10.1	Holly loam	5,952	2.1
Hagerstown stony loam	16,640	5.9	Hagerstown silt loam	3,200	1.1
Decatur clay loam	13,888	4.9	Guthrie silt loam	1,600	.6
Hillsboro silt loam	9,216	3.2			
Rough stony land	7,296	2.6	Total	282,240	.....
Huntington silty clay	7,104	2.5			

CLARKSVILLE SILT LOAM.

The soil of the Clarksville silt loam, 7 to 9 inches deep, is a light yellowish to brownish-gray silt loam of a highly siliceous character and containing very little organic matter. At the surface the soil has a light-gray color, but becomes yellower or browner with depth. The subsoil is a yellowish-brown, more compact silt loam or friable silt clay extending to a depth of several feet. Fragments of angular chert are found in both the soil and subsoil, but generally in negligible amounts, being almost entirely absent in all of the leveler areas. The amount increases, however, as the topography becomes more rolling until the stony loam type is reached. In rolling areas, where the drainiage is perfect, the subsoil becomes more clayey in its properties and assumes a reddish cast at a depth of 30 to 40 inches. The other extreme is found in the small, flat areas which have a light-gray soil and a brownish-gray or gray and brown mottled subsoil as a result of poor drainage. Even in the timbered areas the soil is deficient in humus, a condition due in part no doubt to frequent forest fires which burn off all of the leaf mold. Under cultivation it tends to run together, and as a result it bakes and clods a great deal

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worse than a soil of its texture should. These properties also cause much of the rainfall to run off the surface and facilitate the loss by evaporation of that which is absorbed. On the other hand if sufficient organic matter is incorporated in the soil its properties are materially changed; it becomes quite mellow and darker colored, and absorbs and retains moisture well—characteristics very essential to a productive soil. The type, although considered naturally unproductive, responds readily to good treatment and can be improved to a point where it will produce very remunerative crops.

The type occurs over a very large part of the county in the broad belt generally referred to as the "Barrens." To the north, south, and southwest it continues into the adjoining counties, but along the eastern and western edges it gives way to other types. Through all of the leveler sections it is almost continuous, but only caps the main ridges in the rough topography of the Outer Rim. The surface features range from level to moderately rolling. Over extensive areas there is only enough surface relief to afford good drainage. Local spots occur that on account of their level topography are not properly drained. There being but few streams of any consequence, the greater part of the drainage is effected through a system of shallow swales which contain running water only during wet seasons. The largest level areas occur along the divide between the tributaries of the Duck and Elk rivers, extending from near the southwestern corner of the county around to the west and north of Tullahoma, thence to the east of Manchester and continuing to near Summitville. Other extensive level areas are found to the north and northwest of Manchester.

The Clarksville silt loam is a residual soil formed by the weathering of the upper layers of the Fort Payne chert formation, which consists of very siliceous limestones and chert more or less closely interbedded, some of the latter being of a porous fossiliferous character. The fact that the formation gets more cherty with depth accounts for the greater amount of chert on the slopes. Along the eastern edge of the formation where it dips under the Bangor limestone are some areas recognized as the Clarksville silt loam, which are slightly more sandy than the typical soil, and they are generally preferred for agricultural purposes. It is possible that they are derived in part at least from a very siliceous phase of the Bangor limestone. Other areas of this character, though somewhat more broken and cherty, are found in an irregular ridge extending from Summitville to Sainville. The timber growth, while not altogether characteristic of the type, is noticeably less thrifty than on any other upland type of the county, except in the rolling areas approaching the character of the Clarksville stony loam. The growth originally consisted of red and Spanish oak of

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small and medium size, intermixed with a scattering growth of hickory, post oak, and a few other hardwood trees. In some of the cut-over lands black-jack oak has sprung up in abundance, and it is also found in places forming a part of the original growth. A noticeable feature is that the black-jack oak is confined very largely to the more level areas. The small, poorly drained spots support a mixed growth of water-loving oaks, gum, and maple.

The Clarksville silt loam is very irregularly developed, and taken as a whole only a small percentage is under cultivation, vast tracts not being settled at all. Most of the farms are small and usually not very well kept. Corn, the chief crop, yields on an average from 10 to 20 bushels per acre, and wheat, the next in importance, from 8 to 20 bushels per acre. A few of the best farmers more than double these yields as a result of better tillage and the proper rotation of crops. Oats, cowpeas, sorghum, millets, and grasses are grown in a limited way, and give indifferent to fairly good yields. Tobacco and cantaloupes are two promising crops that have been grown on a commercial scale only within the last few years. The results have not always been satisfactory, but generally the fault lies in the methods rather than in the soil. Practically no fruit or vegetables are grown for the market, although this is a very promising line of farming. Strawberries, raspberries, and blackberries, and a great variety of vegetables do well.

To improve this type a good supply of humus in the soil is very necessary. This can best be done by applying stable manure and practicing a systematic rotation of crops in which cowpeas should play an important part. A rotation that has given very satisfactory results is to plant to cowpeas in the spring, oats and wheat in the fall, cowpeas again the next spring, then to grass and clover for two years. The land should have a good deep plowing in the fall and again in the spring, planting to peas, either cutting the hay or turning tops under for green manure. In case the cowpea crop is light the whole, tops and all, should be turned under. A small application of lime would help. After the cowpea crop, the land should be broken deep and harrowed to good tilth. When the oats or wheat is planted an application of 200 to 300 pounds of a high-grade potash and phosphate fertilizer would prove profitable. Following the grain in the spring should be another cowpea crop to be turned under, after which grass and clover should be sown, or, if preferred, corn might follow the cowpeas. Tobacco should not follow cowpeas, but would be all right after corn. The soil should be made as productive as possible for cantaloupes. As this soil is not unduly acid it does not need heavy applications of lime.

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The average results of mechanical analyses of fine-earth samples of the soil and subsoil of this type are given in the following table:

Mechanical analyses of Clarksville silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19453, 19455	Soil	0.0	0.9	0.8	5.2	6.5	71.6	14.7
19454, 19456	Subsoil	.3	.7	.6	3.8	4.4	70.5	19.6

CLARKSVILLE STONY LOAM.

The Clarksville stony loam, to a depth of 6 to 9 inches, is a light brownish-gray stony silt loam, underlain by a light-yellowish heavier silt loam or a yellowish-brown silt clay, depending upon the topography. As a rule the subsoil is heaviest in the less broken areas, while in the rougher areas there is usually not much difference in the color or texture of the soil and subsoil. The surface is very thickly strewn with angular fragments of chert, and anywhere from 20 to 50 per cent of the same material occurs through the soil mass, the quantity generally increasing with depth until bed rock is encountered. Layers of chert are of frequent occurrence in the subsoil, even within a few feet of the surface, but very few of these occur as ledges except on some of the precipitous slopes. The soil is rather difficult to till on account of the rough topography and stony character. Otherwise its properties are favorable to plant growth, and by many it is preferred to the Clarksville silt loam which is practically free of stones and is level enough to permit the use of all kinds of improved machinery.

The Clarksville stony loam is confined to the rolling and broken areas of the Fort Payne chert formation. It occurs principally in the western half of the county, where the streams in their rapid descent to the lower lands of the central basin have cut numerous narrow and deep valleys in the edge of the Highland Rim. Most of the streams here have cut entirely through the chert and far down into the underlying Chickamauga limestone, which gives rise to entirely different soils. The Clarksville stony loam caps all of the higher outlying peaks and broken ridges of the Highland Rim and extends down the slopes to the edge of the limestone. It extends all the way across the small valleys where the limestone has not been exposed. A number of small areas are scattered here and there through the main body of the Clarksville silt loam.

The drainage of the type is perfect, and were it not for the large quantity of stones on the surface erosion would be excessive. The stony mulch not only prevents erosion to a large extent, but by retarding the flow of the water a much greater proportion of the rainfall soaks into the soil than would be the case in a less stony type of

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soil. In dry weather this mulch is just as effectual in preventing excessive evaporation from the surface. The drainage is so thorough that very large quantities of organic matter can be incorporated in the soil without any danger of developing acidity or other properties inimical to plant growth. The type was originally timbered with a rather heavy growth of red, Spanish, and white oak, hickory, tulip, chestnut, etc., many of the trees reaching an enormous size. In the areas still forested nearly all of the best timber has been cut for lumber.

A relatively larger proportion of this type is under cultivation than of the Clarksville silt loam. On the slopes, where it is the only type, it is farmed quite extensively, but with the more productive limestone soils only small, scattering areas are cleared. Corn is the principal crop. The yields range anywhere from 10 to 30 bushels, averaging possibly not more than 15 bushels per acre. Wheat and oats are grown in a very limited way and give quite variable yields. Sorghum is grown in small patches by nearly all of the farmers, and as a rule it does well. Millets and some of the grasses give good crops of hay if properly cared for. Some farmers have tried tobacco on a small scale, and occasionally good results are obtained. The soil, however, is too rough and stony for a crop like tobacco, which requires a good seed bed and careful, thorough cultivation.

The present system of farming gives only a meager income and does not justify the expense of the labor and time involved. Fruit growing is possibly the most promising industry for the type; yet no fruit is being grown on a commercial scale. Peaches should do exceptionally well, also pears, apples, and some of the berry crops. Only the best areas should be used for corn, hay, and such other crops as can be consumed to advantage at home. Instead of selling the corn it would be much better to feed it to hogs and thus convert it into a more marketable product. For the same reason every farmer should keep at least a few cattle of the improved breeds. Many of the rough areas could be converted into good pasture lands. The very broken areas should remain forested, or if cleared should be replanted with forest trees.

GUTHRIE SILT LOAM.

The Guthrie silt loam or "Gray lands," as it is called, consists of 7 to 9 inches of light-gray silt loam of a close, compact nature, underlain by a light-gray, compact silt clay mottled with yellowish and rusty-brown iron stains. The mottling begins near the surface and grows more intense with depth to about 30 inches, from which point it continues the same for several feet. The soil is deficient in humus and does not work up at all well under the plow. It bakes and clods badly and is not easily reduced to a good tilth.

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This type, the least extensive of all the soils, has been formed by the weathering of the Fort Payne chert formation in slightly depressed, poorly drained areas, which are often found throughout the leveler bodies of the Clarksville silt loam. Some areas occur as long, narrow strips along the shallow drainage swales, and others as irregular bodies with one or more outlets. The majority of the areas were too small to be shown on the accompanying soil map, but whatever their size they are all of the same general character. The soil is kept soggy, except during the driest seasons, and even then the water table is only a few feet below the surface.

A part of the largest area on the road between Manchester and Hillsboro seems never to have been timbered, for which reason it is referred to as "the Prairie." The soil here contains enough humus to give it a darker color than in the general run of the type, the subsoil being about the same as elsewhere. With the exception of this small area, the type supports a heavy growth of white, willow, and water oak, maple, and gum.

On account of its low-lying position, wet character, and unproductiveness, this type is considered of little agricultural value. None of it has been drained and little effort has been made to cultivate it. Corn gives very light and uncertain yields. If cleared and provided with surface drainage, Japan clover and grasses would spring up and afford fairly good pasturage.

The results of mechanical analyses of the soil and subsoil are shown in the following table:

Mechanical analyses of Guthrie silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19461	Soil	0.2	0.8	0.6	5.0	11.7	62.7	18.8
19462	Subsoil	.0	.6	.4	3.3	6.6	59.7	29.4

HAGERSTOWN STONY LOAM.

The Hagerstown stony loam consists of 9 to 12 inches of a dark-brown friable, silty clay loam or heavy silt loam, underlain by a yellowish-brown silty clay. Except in local spots, limestone fragments are abundant in the soil and subsoil and the surface is strewn with the same material, as well as being frequently broken by outcrops of massive limestone. Nearly all of the upper slopes are also strewn with chert worked down from the Clarksville stony loam areas. The depth to bed rock ranges from nothing where it outcrops to 6 feet or more below the surface. In areas where rock is encountered within 3 feet of the surface the soil and subsoil are

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usually more claylike in their properties than where the depth is greater. In many places along the lower slopes where the shading has been dense and there is at least a small amount of seepage the soil and upper subsoil are very dark colored and quite loamy. Throughout the type the soil is well supplied with humus and has good loamy properties.

The Hagerstown stony loam is confined to the very rolling and broken areas in the western part of the county. It begins at elevations just below the Clarksville stony loam and extends all the way down to the streams, or, if in the wider valleys, to the edge of the Hagerstown silt loam areas, which occupy still lower positions. Local areas are moderately rolling, but most of the slopes are very steep and rugged, and areas left bare are subject to destructive erosion.

The Hagerstown stony loam is derived from the Chickamauga limestone. Immediately above the limestone formation is a narrow band of the Chattanooga black shale which could not be outlined on the soil map. The soil here varies with the topography. On the steep slopes the shale is buried by cherty material, while in other areas it partakes more of the nature of the limestone soil, being very dark in color. The Hagerstown stony loam represents an intermediate condition between the Hagerstown silt loam on the one hand and Rough stony land on the other. As on the Hagerstown silt loam, the original timber growth consists very largely of beech and oak.

This type is very productive, but on account of its steep topography and stony character only a small percentage is under cultivation. The best areas, while rather difficult to handle, produce good crops of corn, oats, or wheat. The rougher areas are nearly all cleared and used as pastures.

The results of mechanical analyses of fine-earth samples of soil and subsoil are given in the following table:

Mechanical analyses of Hagerstown stony loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19471	Soil	1.4	3.0	1.1	1.7	2.5	63.8	26.5
19472	Subsoil	1.4	3.0	1.0	1.5	1.4	59.6	31.9

HAGERSTOWN SILT LOAM.

The Hagerstown silt loam consists of 6 to 9 inches of a brown friable, silty clay loam or heavy silt loam, underlain to a depth of about 30 inches by a yellowish-brown silty clay loam to clay, beneath which for

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several feet is a yellowish-brown silty clay streaked to some extent by rusty-brown iron stains. Small fragments of partially weathered limestone are scattered over the surface and to a less extent through the soil. In some areas approaching the character of the Hagerstown stony loam the surface is broken here and there by outcrops of massive and flaggy limestone, but except in such areas the bed rock is not encountered within 5 to 8 feet of the surface. The soil, though rather heavy in texture, contains enough organic matter to make it loamy and easy to keep in good tilth.

The Hagerstown silt loam is a residual soil derived from the Chickamauga limestone, occurring along the western edge of the county as rolling valley lands. Its principal development is in the vicinity of Beechgrove, where the high, broken ridges give way largely to lower rolling lands. Other areas occur farther south along Noah Fork and the Duck River. The topography is generally of a rolling character, except in a few small areas skirting the streams as old terraces or bench lands, which range from nearly level to undulating. Parts of these old terraces no doubt were originally covered with alluvial deposits, which have been long since removed, and the soil now is as truly residual as that of the higher lying areas. The only semblance of any alluvial material is a small amount of subangular gravel strewn over the surface. The natural drainage is very good.

Being naturally very productive and comparatively easy to handle, practically all of the type has been brought under cultivation. Corn, wheat, oats, and grasses are the chief crop. Considerable attention is also given to the raising of cattle and hogs, especially where the type is farmed in conjunction with the Hagerstown stony loam.

Under the prevailing system of farming corn produces from 30 to 40 bushels, wheat 15 to 25 bushels, oats 40 to 60 bushels, and grasses from 1 to 1½ tons of hay per acre. Bluegrass is indigenous to this soil and grows luxuriantly wherever it is given a chance. Clover does well without any special care. Alfalfa is not grown, but should give excellent results. In the line of fruits apples do best.

The average results of mechanical analyses of samples of soil and subsoil of this type are given in the following table:

Mechanical analyses of Hagerstown silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19467, 19469.....	Soil.....	1.4	3.8	1.7	3.1	3.7	62.3	24.1
19468, 19470.....	Subsoil.....	1.4	3.6	1.4	3.1	3.8	49.1	37.7

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HILLSBORO SILT LOAM.

The soil of the Hillsboro silt loam, 6 to 9 inches deep, is a yellowish-brown to brown silt loam, containing little or no stone except in local areas, where there may be quite a sprinkling of porous chert and rotten siliceous limestone fragments. The soil has a low humus content, but works up well under the plow and does not bake badly after rains. When plowed dry the surface soil has a brownish-gray cast, being lighter in some places than others, depending upon the depth to the subsoil. The soil grades rapidly into a yellowish-brown silty clay loam, which in turn gives way within a few inches to a friable silty clay of about the same color. At a depth of 27 to 36 inches the clay usually becomes more compact and plastic and changes from yellowish brown to a pronounced red. In many areas a reddish cast is found within a short distance of the surface. The type in productiveness is intermediate between the Clarksville silt loam and the Decatur clay loam.

The Hillsboro silt loam is not an extensive type, but occurs in a number of areas, the largest of which are in the eastern part of the county. Some of the small areas occur farther west through the main body of the Clarksville silt loam. The surface features are just rolling enough to provide good drainage without any serious damage from erosion.

Except in a few areas, where it seems to be from the more calcareous layers of the Fort Payne chert formation, the type is derived from a siliceous phase of the Bangor limestone.

The Hillsboro silt loam supports a good growth of hardwood trees, including red, Spanish, and post oak, hickory, chestnut, and dogwood. A large percentage of the type is cultivated to the general crops, of which corn, wheat, and oats are the most important. The average yield of corn is not more than 20 to 25 bushels per acre, although on the best farms 40 to 50 bushels per acre is not considered an unusual yield. Wheat yields from 8 to 20 bushels, and oats from 30 to 50 bushels per acre. Grasses, sorghum, and millets, which are grown in a limited way, give fair yields. The type can not be considered especially adapted to clover, but if the soil is properly prepared good crops are produced. Very little attention is given to stock raising, an industry that should receive more consideration by all of the farmers. Tobacco and cantaloupes, neither of which is now grown, would do well.

The average productiveness of this type is not half what it should be, owing to improper methods of tillage. The first object in any system of improvement should be to get a good supply of humus in the soil. Then a number of crops not now considered as adapted to the

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type could be profitably grown. The system of improvement suggested for the Clarksville silt loam applies equally as well to this type.

The following table gives the average results of mechanical analyses of samples of soil and subsoil of the Hillsboro silt loam:

Mechanical analyses of Hillsboro silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19463, 19465.....	Soil.....	0.8	1.9	2.5	11.9	11.2	58.6	13.0
19464, 19466.....	Subsoil.....	.6	1.1	1.8	8.0	7.9	53.8	26.7

DECATUR CLAY LOAM.

The Decatur clay loam consists of 4 to 5 inches of a reddish-brown silty loam or brownish-red clay loam, underlain to a depth of several feet by a red heavy clay. In the levelest areas the soil generally is a good friable loam of a dark reddish brown color, but as the surface gets more rolling the soil is correspondingly shallower, redder, and more claylike in its properties until the knolls and steeper slopes are reached. Here practically all of the loamy material has been washed off and the soil is not much different from the subsoil. These differences occur quite locally and give a newly plowed field a somewhat spotted appearance. The type for the most part is devoid of stone in either the soil or the upper subsoil, but areas here and there have scattering fragments of limestone strewn over the surface and on some of the steeper slopes there may be occasional outcrops of limestone. The organic content of the soil is entirely too low to get the best results except in the more loamy areas. However, the type as a whole is naturally productive and responds well to proper cultural methods.

The largest areas of Decatur clay loam are found in the southeastern part of the county, following out areas of the massive Bangor limestone. Several small areas of the same origin occur around Hickerson. A number of other areas are found northeast of Summitville, and near Mud and Little Hickory creeks. The topography is of a general rolling character and the natural drainage is very good.

The type being highly prized is nearly all under cultivation. Corn, wheat, and oats are the chief crops. A smaller acreage is devoted to grasses, clover, millet, and cowpeas for hay, sorghum for forage and sirup, and several other crops of minor importance. Some areas are sown to grass for pasturage. Corn yields 25 to 50 bushels, wheat 12 to 25 bushels, and oats 30 to 60 bushels per acre. The wide range in yields is not due so much to any inherent differences in the soil, but to the different methods of cultivation. Alfalfa would prove a promising crop if introduced.

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The present system of farming should be changed for one in which cattle and hog raising play a more important part. This would not only increase the resources of the farm, but serve as a means of keeping the soil in a highly productive state. As it is now, the revenues of the farm are derived very largely from the sale of the grain crops. Hay crops which are not now grown to any extent for the market would prove more remunerative. The areas badly washed and inclined to be broken should be plowed thoroughly and planted to cowpeas a few times, then sown to grass for pasturage.

The following table gives the results of mechanical analyses of soil and subsoil of this type:

Mechanical analyses of Decatur clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19459	Soil	0.2	1.2	1.9	12.7	7.9	55.7	20.4
19460	Subsoil	.0	.8	1.4	8.2	6.8	42.1	40.8

ELK LOAM.

The soil of the Elk loam, 6 to 8 inches deep, is a brownish-gray loam, with the sand content principally of the finer grades. The subsoil in the typical areas is a yellowish-brown heavy, fine sandy loam or fine sandy clay usually somewhat mottled below a depth of 2 to 3 feet. A minor phase near the mountains has a heavier yellowish-brown clay subsoil, and some areas have a limited amount of small, partially rounded quartz gravel in the soil and a somewhat larger amount in the subsoil at a depth of 3 or more feet. The soil is not so well supplied with organic matter as it should be to give the best results, but it is fairly mellow and can be easily brought to a good tilth.

The Elk loam occurs in the eastern part of the county as second terraces and as colluvial upland intermediate in elevation between the present overflow bottoms and the Decatur clay loam areas. The areas south of Hillsboro along Beans and Bradley creeks are true terraces or second bottoms, also most of the large area in the southeastern corner of the county and the strip extending up by Glen to Womacks store. Another terrace strip skirts Bradley Creek from near Hillsboro to the edge of the mountains. The narrow strip east of Hillsboro extending across from Bradley Creek to Beans Creek occupies a slight depression, having the appearance of an old abandoned drainage way. Other areas at and near the base of the mountains have the appearance of being in part true uplands, although rather low and flat. All but the lowest level areas have fairly good natural drainage.

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The type is derived very largely from old alluvial deposits of local limestone origin except in the heavier phase or colluvial upland which is of residual origin from a fossiliferous phase of the Bangor limestone. This soil material has been carried down by the force of gravity and deposited at the foot of the slopes where it occurs. This phase is so limited in extent that it was not deemed desirable to separate it as a different type. The quartz gravel and some of the coarser sand in the soil have been brought down from conglomerates and sandstone far back in the mountains.

The original timber consists of a heavy growth of red, Spanish, white, and other varieties of oak, intermixed with scattering hickory, etc.

More than one-half of the type is under cultivation, being used principally for corn, wheat, oats, and grasses. Many other crops are grown in a limited way, and a considerable acreage is devoted to pasturage. Corn yields 25 to 40 bushels, wheat 10 to 20 bushels, and oats from 30 to 50 bushels per acre. Of the grasses, redtop, or herd's-grass, and timothy give the best results. Clover is not grown to any extent, but good stands can be had if the land is put in proper condition. Some of the best areas, if properly prepared, would grow good alfalfa.

A greater diversity of crops should be grown and more attention given to crop rotation, with the idea of keeping the soil in a highly productive state. Cowpeas should always be planted with the corn crop. This would give two crops at once and at the same time put the soil in much better condition for the grain in the fall. Follow the grain with cowpeas in the spring and the latter with grasses or clover in the fall, or wait until the next spring and plant again to corn.

The following table gives the results of mechanical analyses of fine-earth samples of soil and subsoil of this type:

Mechanical analyses of Elk loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19473	Soil	1.3	6.5	12.1	26.9	9.5	33.4	10.2
19474	Subsoil	1.0	4.9	9.5	19.6	6.6	36.4	22.0

ROUGH STONY LAND.

Rough stony land comprises any rough and broken areas where rock outcrop occurs over the surface to such an extent as to render them unfit for any cultivated crops, although supporting a growth of timber or some grass for pasturage. By cutting off the timber and allowing native grasses to take possession all but the roughest stony areas can be developed into fairly good pasture lands.

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The largest areas mapped include the mountainous strip along the eastern edge of the county. Here the surface is very rough and the Bangor limestone outcrops extensively, besides occurring over the surface in numerous loose fragments. The soil for the most part is a yellowish-brown to brown clay loam or clay 4 to 8 inches deep, underlain by a yellowish-brown stiff clay. A few small areas were mapped in the western part of the county from the Chickamauga limestone. The soil of these areas varies from a brown stony clay to a stony clay loam, as found in the Hagerstown stony loam areas.

Parts of the small areas have been cleared for pasturage but the mountains are still timbered with oak and other hardwood trees.

HUNTINGTON SILTY CLAY.

The Huntington silty clay being of alluvial origin and confined to very narrow bottoms, is quite variable, but may be described in general as a dark-brown or brownish-gray fine loam, to silty clay 9 to 15 inches deep, underlain by a dark-brown to black silty clay.

Following out the broader differences in the source of the material, the type is divided into two important phases. One of these is represented in the areas along the Duck River and its tributaries, where the drainage is mainly from the Chickamauga limestone formation. Here the soil is a dark-brown, rather heavy fine loam or silt loam 12 to 15 inches deep. The subsoil is a dark-brown heavy silty loam to loamy silty clay, giving way at a depth of 3 or more feet to beds of gravel, or extending down to the bed rock. In many places the surface is strewn with subangular gravel, especially immediately along the streams. Except in very local spots, however, there is not enough gravel in the soil seriously to interfere with agricultural operations.

The other phase is confined to the eastern part of the county, where the drainage is from the Bangor limestone areas. The soil, 8 to 12 inches deep, is a dark-gray to black loam, underlain by a dark-gray or black compact clay loam. Both the soil and subsoil contain a noticeable amount of medium and fine sand and scattering fragments of quartz or quartzose sandstone brought down during floods from the Lookout sandstone formation back in the mountains. Except for these small quartz fragments the soil and upper subsoil are free of gravel.

The surface of the type is level or nearly so. Wherever the bottoms have much width there are generally two terraces, the first being immediately along the streams and subject to overflow during every wet spell, and the second extending back to the edge of the highlands and reached only by the highest floods. As a whole the areas in the western part of the county are better drained than those

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in the eastern part, and mainly for that reason are more highly prized for agricultural purposes.

The behavior of the soil under cultivation varies directly with the character of the drainage. In areas subject to frequent overflow or for any other reason not properly drained the soil clods badly and can not be reduced to a good tilth, while in the higher, better drained areas it works up as well as a soil of similar grade in the highlands.

A very large percentage of the type is under cultivation. The uncleared areas are confined mainly to low, wet, or stony strips immediately along the streams, these being heavily timbered with beech, oak, sycamore, elm, and birch. The cultivated areas are devoted mostly to corn and grasses. When the seasons are good corn yields from 30 to 60 bushels, and grasses from 1 to 2 tons of hay per acre. The best drained areas produce heavy crops of oats. Sorghum, millets, and many other crops do well. Some areas are used as pasture lands.

The results of mechanical analyses of soil and subsoil of the Huntington silty clay are given in the following table:

Mechanical analyses of Huntington silty clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19475	Soil	0.0	0.3	0.3	4.5	7.2	61.9	25.6
19476	Subsoil	.0	.1	.0	1.4	4.9	61.2	32.4

HOLLY LOAM.

The Holly loam is an alluvial type including the bottom lands where the drainage is entirely from the Fort Payne chert formation. The soil 8 to 12 inches deep is a gray or brownish loam, varying from very silty to rather sandy, according to the size of the areas and their position with reference to the streams. The sandiest areas are found immediately along the streams where the water flows swiftest during overflows, the soil becoming gradually finer and more compact back toward the slopes. The subsoil varies in color and texture directly with the soil. Where the soil is of a fine silty nature, as is the case in a very large proportion of the type, the subsoil is a gray mottled compact silt loam or silty clay loam, usually extending to considerable depth, though in some places there is a change to a lighter gray mottled silty clay at a depth of about 27 inches. The sandiest phase of the soil is underlain by a brownish fine loam or clay loam carrying small amounts of chert gravel. The soil clods badly under cultivation and is not near as productive as the Huntington silty clay.

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This type is not extensive, but occurs along all of the streams of any size through the "Barrens" or Clarksville silt loam belt. The largest areas are found north of Manchester along the Duck River. Others occur along Little Duck River, Barren Fork of the Cumberland River, Mud and West Fork Hickory creeks, and a few small streams farther south. The natural drainage is poor except in local terraces of a semiupland character. In all of the lower areas overflows are frequent and the water table stands near enough the surface to keep the soil wet and clammy. The timber growth consists of water-loving oaks, maple, birch, and gum.

Small areas here and there are cultivated principally to corn, which gives light and uncertain yields. Instead of trying to cultivate this soil a better plan would be to clear it for pasture lands. Japan clover and several native grasses flourish and are relished by stock.

SUMMARY.

Coffee County, with an area of 282,240 acres, or 441 square miles, is situated in the Highland Rim, near the center of Tennessee, being in direct line and about halfway between Nashville and Chattanooga. A very large part of the county, locally termed the "Barrens," is level to gently rolling, but the western edge is mostly of a rough and broken character, and a narrow strip along the eastern edge is in the mountains. The range in elevation is from 600 feet in the deep valleys along the western boundary to 2,000 feet in the mountains, the intervening section being about 1,100 feet above sea level. The drainage is mainly to the south and west through the Elk and Duck rivers.

The limestone sections are very well settled, but the "Barrens" is only sparsely settled, and vast tracts are not occupied at all. There is only a small negro population in the county.

Fairly good transportation facilities are afforded by the main line and the Sparta branch of the Nashville, Chattanooga and St. Louis Railway. The rural delivery service reaches all sections of the county.

Manchester and Tullahoma, with a population of about 1,000 and 3,000, respectively, are the chief towns and local marketing centers.

The climate is cool and healthful and adapted to a variety of crops. The growing season is about six months long. The prevalence of cool nights through the summer months keeps cotton from becoming one of the staple crops. Late spring frosts make the peach crop rather uncertain, but generally there is a good crop of apples and other fruits.

The system of cropping has not undergone any radical changes since the early settlement of the county. Corn and wheat are the

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main crops. Of the live stock, cattle and hogs receive chief attention and are important industries with many of the farmers on the limestone soils.

No systematic rotation of crops is practiced except by a few of the most progressive farmers. Commercial fertilizers are used extensively on the light soils where the yields are generally unsatisfactory. The tendency has been to grow the same kind of crops on all types of soil, but the farmers are gradually getting away from this practice and are giving more attention to the adaptation of certain soils to certain crops.

The farms generally contain from 100 to 300 acres; the tenant holdings are about 100 acres or less. About 56 per cent of the farms are operated by the owners, a few by overseers, and the remainder mainly by white tenants.

Land values as a whole are quite moderate. The best limestone lands range from $40 to $75 an acre; while through the "Barrens" the price ranges from $5 to $20 an acre.

Day laborers get from 60 to 75 cents a day and regular help from $13 to $18 a month.

The soils of the county are representative of the Highland Rim and some of them have extensive development in other sections of Tennessee. They bear a direct relation to the underlying geological formations. Including the Rough stony land, 11 types of soil were mapped.

The Clarksville silt loam, a very extensive type, is used principally for corn and wheat, though tobacco and cantaloupes have become promising crops within the last few years. For the successful growing of general crops it is necessary to practice a systematic rotation. This is not naturally a strong, productive soil, but by incorporating organic matter and using proper tillage methods good yields can be secured.

The Clarksville stony loam occupies very rolling to rough areas. It is cultivated quite extensively to corn, and a few other crops are grown in a more limited way. It is best adapted to fruits, especially apples and peaches. All of the rougher areas should be pastured or left timbered.

The Guthrie silt loam is a poorly drained soil of limited extent and is not farmed. It can be cultivated if properly drained. If cleared of timber growth it would be good pasture land. Japan clover grows luxuriantly without any care.

The Hagerstown stony loam is naturally a very productive limestone soil, used mostly for pasture land. Small areas are cultivated to corn and other crops and the yields generally are good.

The Hagerstown silt loam is the most desirable of the upland types, being naturally very productive. Corn, wheat, oats, grasses, and

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clover are the crops grown, and good yields are secured. Alfalfa would do well.

The Hillsboro silt loam, while not as productive as the Hagerstown silt loam, is a good soil for general farm crops, and would produce good tobacco and cantaloupes. To get the best results the soil should have more humus.

The Decatur clay loam is a red soil of limestone origin. Corn, wheat, oats, and forage crops all do well. Alfalfa would be a promising crop on this soil.

The Elk loam is used principally for corn, wheat, oats, and grasses. Some areas would grow good alfalfa.

The Huntington silty clay is an alluvial type of limestone origin. It is naturally very productive and is highly prized for corn and forage crops.

The Holly loam is an alluvial type occurring through the "Barrens." It is not very productive and is poorly drained in most places. Small areas are devoted to corn and grasses. Its best use is for pasturage.

The Rough stony land is practically all timbered, and should remain so.

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SOIL SURVEY OF THE PARKERSBURG AREA, WEST VIRGINIA.

By F. N. MEEKER and W. J. LATIMER.

DESCRIPTION OF THE AREA.

The Parkersburg area is located in the northwestern part of West Virginia and comprises the adjoining counties of Wood, Ritchie, and Pleasants. Wood County contains 357 square miles, Ritchie 457, and Pleasants 142, thus making the area covered by the survey 956 square miles. The area is bounded on the north by the Ohio River

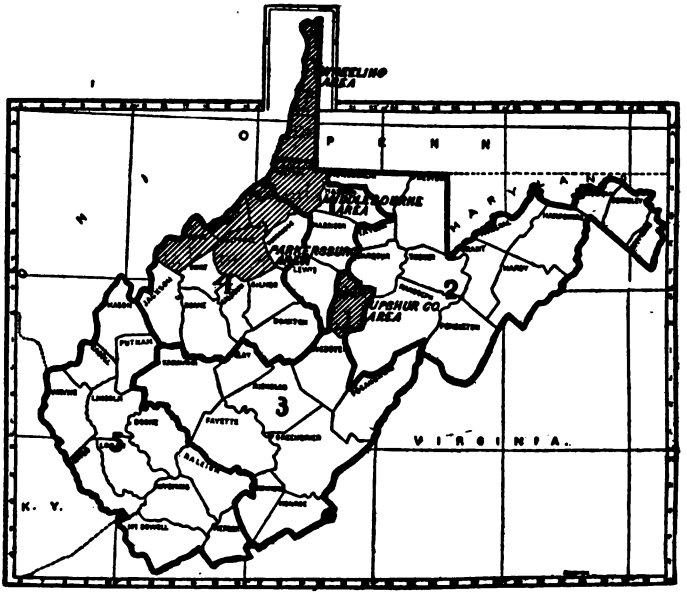

FIG. 28.—Sketch map showing location of the Parkersburg area, West Virginia.

and Tyler and Doddridge counties; on the east by Tyler, Doddridge, Gilmer, and Wirt counties; on the south by Gilmer, Calhoun, Wirt, and Jackson counties; and on the west by Calhoun, Wirt, and Jackson counties and the Ohio River. In an east-and-west direction it has a length of about 50 miles, while from north to south its greatest width is about 33 miles.

All of the upland of the Parkersburg area is very rough and hilly. From many of the hilltops and ridges the region presents a pic-

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turesque appearance, resembling a very mountainous country on a small scale. The hills often converge to sharp peaks, while the ridges are in many cases only a rod or two wide. The most of the hillsides are steep and the valley bottoms are usually very narrow. Although the topography of the area is rough throughout, generally speaking, the roughest areas are to be found along the streams flowing into the Ohio and Little Kanawha rivers. Immediately along these rivers the country is, if anything, less broken than that along their tributaries. A large number of the smaller streams throughout the area have valley walls rising quite abruptly from 100 to 400 feet above the stream bed. The hillsides are often precipitous in character and in many cases show massive sandstone rock strata from 20 to 30 feet in thickness, while in others they are seen to be strewn with huge, irregularly shaped bowlders which have been broken off the underlying rock strata occurring farther up the hillsides. The high and low water levels of the Ohio River, as given by the United States Geological Survey, in the southwestern part of the area near Belleville, are 606 and 550 feet above sea level, respectively. At Parkersburg the same levels are 618 and 564; at Marietta, 621 and 570; and at Long Reach, a point about 2½ miles north of this area, they are 632 and 581 feet, respectively. One of the highest peaks in the area is Kings Knob, in Ritchie County, about half a mile south of Five Forks. It has an altitude of 1,367 feet, so that within the area there is a range in elevation of over 800 feet.

In the western part of the area, between Lubeck and the Ohio River, the topography is somewhat more gently rolling. The same is true in a few sections near the Little Kanawha River, but outside of these sections a topography of this character is seldom seen in the uplands, except here and there over small areas on the somewhat broadened ridge tops.

The most valuable farming land in the Parkersburg area is the bottom land, occurring irregularly along both the Ohio and Little Kanawha rivers. Its greatest width along the former river is about three-fourths mile, while along the latter it sometimes reaches a width of a mile. A very noticeable feature about the bottom land along the Ohio is that it is in many places made up of quite well-formed terraces, the height of one terrace above another varying from about 5 to 20 feet. Above the so-called "first bottom" the terraces are locally termed "second" and "third" bottoms. Only a comparatively small amount of first bottom occurs along the Little Kanawha River, the largest area being only a short distance from its mouth, at Tavennersville. Nearly all of the remaining bottom land along this stream as it occurs in this area lies at a higher point above water level, and at Tavennersville a high and well-defined terrace is seen.

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The Ohio River receives the drainage waters of the entire area. It has an average width of about one-fourth of a mile and forms the northwestern boundary of both Wood and Pleasants counties. The largest stream flowing through the area is the Little Kanawha River. This stream rises in the central part of the State, in Upshur County, and flows in a northwesterly direction, crossing the southeastern boundary of Wood County, 2¾ miles east of Leachtown. From this point it flows irregularly in a northwesterly direction, reaching the Ohio River at Parkersburg. The two principal streams in Ritchie County are the North and South Forks of the Hughes River. The North Fork rises in the northeastern part of the county and flows in a southwesterly direction through its northwestern part. The South Fork rises in the southern part of Doddridge County and flows irregularly in a westerly direction through the southern part of Ritchie County. The two forks unite just at the boundary line of the latter county near Cisko, forming the Hughes River proper, which flows in a northwesterly direction through Wirt County, reaching the Kanawha River at the boundary line between Wood and Wirt counties. The principal tributaries of these two streams are Grass Run, Bonds, Spruce, and Bone creeks. A good-sized stream in the northern part of the area is Middle Island Creek. It enters Pleasants County at its extreme northeastern part and flows in a southwesterly direction through the northern part of the county, reaching the Ohio River at St. Marys. The principal smaller stream of Pleasants County is McKim Creek, which enters Middle Island Creek near Union Mills. The principal smaller streams in Wood County are Pond, Tygart, and Worthington creeks. Many of the larger streams are very crooked and wind back and forth, often making loops of half a mile or so. The drainage basin of these streams is made up of an irregular network of smaller streams which very often flow on bedrock through deeply carved V-shaped channels. The depth of these valleys varies from 100 to 400 feet and the fall per mile is often over 100 feet. The main roads are very frequently in these valleys, and in many cases the stream bed is utilized as a road. After leaving the stream the road winds its way up to the top of the divide, only to descend at once into another valley.

The first permanent settlers in this area came mainly from Maryland, Virginia, and Pennsylvania in about 1770 and located along the Ohio River, principally around Williamstown and in the vicinity of Parkersburg. During the following sixty years many others came to the area from the same States, some also from New York and New England, and a few of these were from Scotland and Ireland. Nearly all of the earliest settlers were attracted to the area by the rich lands and the transportation advantages afforded by the Ohio and Little Kanawha rivers. Others coming later located along the principal

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streams some distance away from these rivers. The present farming population is made up principally of descendants of the original settlers. The other classes are composed of those who have been attracted here in recent years, mainly on account of the discovery of oil and gas. Only a very few negroes are found in the area, and almost all of these are at Parkersburg.

The population of the counties forming this survey at each decennial period, commencing with 1820, is shown in the table following:

Population of the counties comprising the Parkersburg area.

County.	1820.	1830.	1840.	1850.	1860.	1870.	1880.	1890.	1900.
Wood	5,860	6,429	7,982	9,450	11,046	19,000	25,006	28,612	34,452
Ritchie	.....	.....	.....	3,886	6,809	8,992	12,184	16,621	18,901
Pleasants	.....	.....	.....	.....	2,945	3,012	6,256	7,539	9,345

Wood County was formed from Harrison County by act of assembly passed December 21, 1798. The act creating Ritchie County was passed February 18, 1843, the county being made up of parts of Lewis, Harrison, and Wood. Pleasants County was formed from territory taken from Wood, Tyler, and Ritchie on March 29, 1851.

The largest town within the area is Parkersburg. It is a thriving city and is growing rapidly. The census of 1900 gave the population as 11,703, and conservative estimates place the present population at about 22,500. It not only has a large number of manufacturing plants, but it also is an important center for both jobbing and retail trade. St. Marys is also a thriving place. The population has probably doubled since 1890 and is now thought to be about 2,000. Both of these places are situated on the Ohio River. Two other small but quite important places, located on the same river, are Belleville and Williamstown. The city of Marietta, in Ohio, is located directly across the river from the latter place. Pennsboro, Cairo, and Harrisville are three other enterprising towns in Ritchie County. The first two are situated on the main line of the Baltimore and Ohio Railroad, while the latter is at the terminus of the Lorama Railroad, a line connecting with the Baltimore and Ohio Railroad at Pennsboro. Throughout the area there are a large number of smaller but thriving places having from 100 to 200 inhabitants.

The most important industry in the area is that of obtaining petroleum. This was first begun in about the year 1864, when oil was found at Volcano. Within a short time after this many other wells were drilled near this place, and for a period of fifteen years the production was very large. It, however, gradually decreased until at the present time only a comparatively small amount of oil is obtained from that field. In 1879 the town was burned, and since

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then little or nothing has been done toward rebuilding it. About 1890 both oil and gas were discovered in other parts of the area, and as a result the business activity in several of the towns was increased very materially. At the present time producing wells are to be found over the larger part of the area and many new ones are being sunk. The lands are usually leased to the oil companies for a stipulated price per acre, which amount is ordinarily paid to the owner of the farm until a well is obtained, when in the place of the rental the farmer receives a royalty of one-eighth of the oil produced. The oil production within the area at the present time is not as large as it was in the earlier history of the industry.

About 1865 an asphalt mine was discovered near Macfarlan, and for a number of years a material of high grade was obtained from it, but at the present time it is worked only in a small way. Through the area there are a few small coal mines, but none of them have a production other than for local use. Sandstone is quarried in several places for building purposes.

The area is well supplied with transportation facilities. The Baltimore and Ohio Railroad extends from Parkersburg east through Cairo, Ellensboro, and Pennsboro, thus giving through connections with all eastern points. At Parkersburg the same road connects with Cincinnati, St. Louis, and other points to the west. Following the Ohio River on the West Virginia side is the Ohio River division of the Baltimore and Ohio Railroad, connecting all points in the area along the river with Pittsburg to the northeast and with Kenova and intervening points to the southwest. Passing from Parkersburg across the river is also the Zanesville branch of the Baltimore and Ohio Railroad, which gives good service to Chicago and points to the northwest. The Little Kanawha Railroad extends from Parkersburg through Wood County along the Little Kanawha River to Palestine, in Wirt County. The Lorama Railroad connects Harrisville, the county seat of Ritchie County, with the main line of the Baltimore and Ohio at Pennsboro. The Cairo and Kanawha Railroad extends from Cairo to Macfarlan, a point in the southern part of Ritchie County. Reaching from Parkersburg to Marietta is an electric line which connects these two places with all intermediate points. This line is equipped to carry both freight and passengers. At the present time two other short railroads are being built within the area—one from Cornwallis to Harrisville and the other from Goose Neck to Pullman, in the eastern part of Ritchie County. The area has excellent water transportation facilities. By this means materials may be shipped both to and from points to the north and northeast or southwest into the Mississippi and its tributaries. The Little Kanawha River also affords good shipping connections with all points in the interior of Wood and Wirt counties.

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The Parkersburg area has a fairly good public road system. In the most hilly sections, however, many of the roads are very rough, and during the winter and after continuous rains are very heavy, especially over areas of red clay. At such times teams of from four to six horses are ordinarily used for hauling purposes. During the summer months the roads are usually in very good condition.

The cities of Parkersburg and Marietta, together with the other smaller places through the area, constitute the local markets. These towns usually furnish a greater demand for general farm and dairy products and truck crops than is supplied from the surrounding country. The most important agricultural products of the area are corn, hay, cattle, and sheep. Of these the last two are the most important. Sheep are raised for both mutton and wool, while the cattle are handled both for veal and for beef. Nearly all of the veal and mutton is sold to local dealers. The principal cattle market is Pittsburg, while that for wool is Philadelphia, though some wool is sold in Pittsburg and Baltimore. The farmers generally sell these products to local dealers, who in turn ship to the distant markets.

Practically the same conditions as regards means of communication exist in this area as are found in southeastern Ohio. Not only are all of the towns and villages connected by telephone, but nearly every farmer is likewise provided with this means of communication. The farmer owns his own instrument and a share in a line leading to some central or exchange point. Small annual fees are paid to meet the expense of line maintenance and for paying attendants at the central points. Throughout the area there are several independent telephone companies of this character, and in most cases arrangements are so made that those having an interest in one line are allowed free service over other lines. The outlay to the farmer is very small and is many times compensated for by the service obtained.

CLIMATE.

The climate of the Parkersburg area is healthful and is well suited to general farming. The annual average temperature is 53° F. The average temperature of the two coldest months—January and February—is about 34° F. The temperature seldom reaches 100° in summer or the zero point in winter. The absolute minimum temperature for Parkersburg during a period of fifteen years is about 27° below zero, while the absolute maximum for the same period is about 102° F. The annual rainfall of the area averages about 41 inches. The greatest precipitation usually takes place during June and July, when it is needed for growing field crops, while the least generally occurs during September, October, and November. Comparatively little snow falls during the winter,

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and this melts quickly, seldom remaining on the ground more than a few days. Some of the more progressive farmers practice winter plowing, and thus gain the benefit to be derived from the alternate freezing and thawing of the ground during this season.

The first table following gives the normal monthly and annual temperature and precipitation for the area, as shown by the Weather Bureau records at Parkersburg, Cairo, and Bens Run. For Parkersburg the data are based on records for nineteen years; for the other stations the records are for the years 1903 to 1907, inclusive. In the last table the dates of the last killing frost in spring and the first in fall are given for the same places, showing the growing season to cover about one hundred and sixty days.

Normal monthly and annual temperature and precipitation.

Month.	Parkersburg.		Cairo.		Bens Run.	
	Temperature.	Precipitation.	Temperature.	Precipitation.	Temperature.	Precipitation.
	° F.	*Inches.*	*° F.*	*Inches.*	*° F.*	*Inches.*
January	33.0	3.50	32.8	4.79	31.0	4.10
February	36.4	3.67	30.0	3.23	29.1	2.52
March	42.4	3.63	47.1	4.88	44.4	5.84
April	53.0	2.95	51.3	4.10	50.3	3.70
May	63.3	3.40	64.0	2.62	62.9	5.29
June	71.5	4.92	69.1	5.21	70.9	4.94
July	75.6	4.66	73.2	4.16	74.4	4.84
August	73.4	3.53	72.7	3.33	74.3	4.39
September	66.1	2.72	68.5	2.96	69.2	2.68
October	54.6	2.44	55.5	3.88	54.5	3.44
November	43.1	2.83	41.4	3.19	42.8	2.07
December	35.2	2.77	33.3	4.11	34.7	4.10
Year	54.0	41.02	53.2	46.46	53.2	47.91

First and last killing frosts.

Year.	Parkersburg.		Cairo.		Bens Run.	
	Last in spring.	First in fall.	Last in spring.	First in fall.	Last in spring.	First in fall.
1901	Apr. 5	Oct. 4	.....	.....	.....	.....
1902	Apr. 15	Oct. 15	.....	Sept. 15	.....	.....
1903	Apr. 5	Oct. 24	May 5	Oct. 19	.....	.....
1904	Apr. 21	Oct. 16	May 16	Sept. 16	Apr. 22	Oct. 7
1905	Apr. 19	Oct. 13	.....	Oct. 13	Apr. 19	Oct. 13
1906	May 10	Oct. 12	May 18	Oct. 12	May 10	Oct. 11
1907	Apr. 20	Oct. 15	May 28	Oct. 14	May 5	Oct. 19
Average	Apr. 18	Oct. 14	May 17	Oct. 5	Apr. 29	Oct. 12

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AGRICULTURE.

In the year 1770 Washington came on his first trip down the Ohio River, seeking locations for the grants given him for services rendered in the French and Indian war, and chose lands along the Ohio River about 7 miles west of Parkersburg, now known as Washington Bottoms. One of the first real settlements in the area, however, was made by people from Maryland at what is now Williamstown, just opposite the mouth of the Muskingum River. In 1773 some Pennsylvanians made settlement at the mouth of the Little Kanawha River, where the city of Parkersburg now stands. A so-called "settlement title" was obtained to 400 acres at this point. At both of these settlements corn, wheat, flax, and Irish potatoes were raised. Both wild game and fish were very plentiful. Shortly after these first settlements, and before many others along the river had become at all permanent, Dunmore's war and a long period of troubles with the Indians occurred. Many settlers to the northeast, about Wheeling, were obliged to take refuge at Fort Henry at Wheeling or to go back to their old homes in Pennsylvania and Maryland until the danger should be passed. After the close of the Revolution, however, the danger from the Indians was not so great and permanent settlers and surveyors began to come back to this locality. In 1785 a party from Pennsylvania came by boat down the Monongahela and Ohio rivers, intending to go to Kentucky. They, however, did not go farther than the mouth of the Little Kanawha, up which stream they went for a short distance, landing on its south bank. This was the beginning of another permanent settlement in this area. At about this same time still another one was started at Belleville. Between the years of 1785 and 1800 quite a large number of new settlers came to this section, locating principally along the Ohio and Little Kanawha rivers. Settlements reached as far up the latter river as Elizabeth, just southeast of Wood County. The principal crops raised were corn, wheat, flax, and potatoes, together with some garden vegetables. Supplies were brought into the country from Pittsburg by boat and from Virginia by wagon and were exchanged for furs and pelts.

Development of the eastern part of the area began about the year 1800. It was first brought into notice through the opening of what was known as the "state road," the act authorizing the surveying and opening of which passed the Virginia house of burgesses in 1789. This road extended from Alexandria, Va., westward over the Allegheny Mountains to the Ohio River, opposite the town of Marietta. From Clarksburg, W. Va., it extended westward through the northern part of the area and was for many years one of the most important thoroughfares between the east and west. At first settlers built cabins at intervals along this road, mainly for the purpose of accommo-

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dating travelers; but within a few succeeding years settlements were made away from the road in several different localities. Probably the first one in the eastern part of the area was made along this road near what is now Pennsboro. A little later, in 1801, another settlement was started in the vicinity of Harrisville. Others were gradually made in other parts until by about 1830 they were quite fairly well distributed over the whole of the area away from the Ohio and Little Kanawha rivers. A great many of the settlers were from Harrison County in this State, but nearly all originally came from Virginia, Maryland, or Pennsylvania. Practically the same crops were grown as by the somewhat earlier settlers in the western part of the area. Early history of Ritchie County states that the settlers usually made trips to Marietta once a year, mainly for the purpose of obtaining salt and iron, which articles they paid for in skins of wild animals and venison hams, supplemented occasionally with snakeroot and ginseng.

Between 1830 and 1840 the Northwest Turnpike was completed. This road passed through the northern part of the area from Parkersburg to Winchester and helped very materially in the development of the country. Up to 1832 there had always been considerable trouble in regard to land titles. In this year, however, the legislature passed an act providing for the quieting of land titles and for the sale of forfeited lands. This gave new impulse to immigration and tended strongly to increase land values. Up to this time the price of woodland ranged from 25 cents to 50 cents per acre. Between 1850 and 1860 another main road in the southern part of the area, known as the "Staunton and Parkersburg Turnpike," was completed. This, too, gave great impetus to improvement. The one thing, however, which more than all other causes combined contributed to the rapid settlement and development of the country was the building of the Baltimore and Ohio Railroad at about this same time. It soon gave origin to the villages of Pennsboro, Ellensboro, Cornwallis, Cairo, and Petroleum. The most recent cause for increased development within the area, although not particularly along agricultural lines, has been the discovery of oil and gas.

The early settlers within the area kept only a few cattle, and it was not until the late forties that they began to be raised for market purposes. These were all of a grade type and were driven overland to eastern markets. In the same way sheep were raised on a small scale almost from the time of the earliest settlements, but the industry was of little importance until after the civil war.

According to the census crop reports corn takes first rank of all the crops grown in the area, showing a steady increase in production from 1840 to 1900. The same authority shows that the production of wheat has varied considerably, being greatest in 1900. The yield

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of oats has also varied, and generally speaking the production has been inversely proportional to that of wheat. Hay has never been an important crop, but the number of tons produced gradually increased until 1890, since which date it has slightly decreased. In 1870 about 43,000 bushels of rye were raised, but since then the production has decreased very materially, until at the present time very little of the crop is grown. Little or no barley has ever been grown within the area. Tobacco has been grown in the area since 1840, but statistics show that the amount produced in 1840 was over four times as great as in 1900. Over 200,000 pounds were produced in both 1860 and 1880, but in 1900 the production was only 20,430 pounds. The decrease has been due mainly to the decrease in prices obtained. A fair amount of buckwheat was grown up to 1880, but since then the production has been small.

Fruit has been grown in the area from an early date. Apples, peaches, and pears were first obtained as seedlings, but later standard varieties were introduced in nearly all parts of the area. The principal varieties of apples grown at the present time are Rome Beauty and Ben Davis. Other varieties are the York Imperial, Northern Spy, Grimes Golden, and Baldwin. Very little of the fruit is disposed of in other than local markets. Peaches are grown in a limited way over the entire area. Several varieties are found here, but the one most preferred is the Elberta, on account of its good shipping qualities. The principal varieties of pears grown are the Bartlett and Kieffer. Grapes are also grown quite generally. The principal difficulties in fruit growing in the area are damaging frosts and loss through winter-killing.

Small fruits, such as strawberries, blackberries, and raspberries, can all be grown successfully within the area. Grapes also do well. The nursery business is carried on to some extent mainly in Ritchie County, in the vicinity of Harrisville. At the latter place a general line consisting of fruit trees, shade trees, and ornamental stock is raised, about 30 acres being under cultivation. The larger part of the seedlings used in grafting stone fruits is imported from France. Apple seedlings are obtained mainly from Kansas, in the locality of Topeka.

The raising of sheep is one of the most important agricultural industries in the area. Nearly all of the early settlers produced wool for home use, but it was not until about 1860 that the industry began to be engaged in on a somewhat larger scale. Spanish Merinos were the principal breed raised at that time. About 1870 Cotswolds and Leicesters were introduced and in 1875 the Southdowns and the Shropshires. The two latter breeds, together with some Dorsets and Delaines, are the principal ones now handled. In 1893 many farmers within the area discontinued raising sheep on account of the

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low price of wool. About six years later, however, better prices were obtained, and as a result the business was extended. At the present time considerable quantities of both wool and mutton are produced.

The raising of cattle is also an important industry within the area. Both beef and veal are produced. The principal breeds handled are Aberdeen Angus, Shorthorn, and Hereford. Quite a large number of Jerseys are kept for dairy purposes. Comparatively few pure-bred horses are raised within the area. An important industry in the locality of Parkersburg is the raising of Shetland ponies.

Considering broadly the question of soil adaptation, the use to which a large part of the lands of the Parkersburg area would seem to be best adapted is the raising of sheep and cattle, both on account of the topography, which is unfavorable to extensive cultivation, and because of the ability of the soils to produce excellent pasture grasses. Some of the pastures have been in grass for over twenty-five years and are still in fine condition. Many of the steep hillsides and ridges are still covered with the original forest or with a second growth consisting largely of locust. Nearly all of the upland soils seem to be well adapted to the raising of fruits, especially apples. The red clay land of the hilly section is considered best for wheat. The lowest bottom land along the Ohio and Little Kanawha rivers is used mainly for corn, while that occurring at the higher levels is valuable for Irish potatoes and truck crops. Some of the more sandy areas lying immediately between the river bottoms and the upland are most valuable for early truck.

The usual crop rotation upon the tillable uplands is as follows: (1) corn, (2) wheat (or oats), (3) timothy and clover, ordinarily allowed to continue for hay from one to five years, after which the field is used for pasture. The timothy is sown in the fall with the wheat and the clover in the early spring. The first hay crop is largely clover, but in the following years the timothy predominates. In sections where there is a sufficient amount of limestone material in the soil the timothy is gradually displaced by bluegrass, which affords excellent pasturage and which remains in good condition from ten to forty years. On the river bottom lands and in the upland valleys the rotation is usually (1) corn, (2) wheat, (3) timothy and clover continued for one to five years, then corn. In other localities on these lands where dairying is an important industry the following rotation is practiced: (1) corn, (2) corn, (3) clover and timothy, (4) clover and timothy. In the fall of the first year a cover crop of crimson clover and hairy vetch or rye is sown on the corn ground and in March or April is plowed under. In the fall of the second year the same ground is sown with timothy and seeded to clover in the following spring. During the two years following the hay crop is cut, after which the field is again plowed up for corn.

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Usually in this section of West Virginia and the adjoining parts of Ohio, the farm methods are those which look forward to obtaining good pasture lands. Where the topography is not too steep, after clearing the land is planted to corn, other crops following in the order of rotation commonly practiced in the hilly uplands. In many instances, however, where the hillsides are very steep clean tillage crops are avoided, as the resulting injury to the land through erosion would be great. In such sections the cutting of the timber growth is generally completed before the early part of July. In August the land is burned over, shortly after which it is broken up as thoroughly as possible for the purpose of preparing a seed bed. Early in September a mixture of redtop, bluegrass, orchard grass, timothy, white clover, red clover, alsike, and rye are sown. The last-named crop, owing to its rapid growth, acts as a cover crop and helps very materially, through its large root development, to hold the soil in place until the root systems of the grasses shall have become well established.

The ordinary method of growing the corn crop in the hilly uplands illustrates the adaptation of methods to the local conditions. The soil is plowed to a depth of 6 or 7 inches, after which the corn is either drilled or planted in rows following the contours of the hills. The sod which is plowed under for the corn crop helps to keep the soil in place during times of heavy rains. By the end of the first year, however, these sods are thoroughly rotted and no longer act to bind or hold the soil together. For this reason corn is seldom planted on the same field two years in succession. In the cultivation of the steep hillsides the farmers quite often cultivate the upper half one year and the lower half the following year. This is done to check erosion, and whatever material is washed from the upper half of the hill is caught in the grass and sod in the lower half. Small depressions, gullies, and the slopes of runs are so far as possible kept in sod to prevent further washing. For the same purpose stones and brush taken from the fields are very often thrown into the gullies and runways. A still further precaution to prevent erosion is often practiced by the best of farmers. This consists in having alternate strips of sod land and corn. The strips are usually 2 or 3 rods wide and follow the contours of the hill. Whatever washing takes place in the corn fields is caught in the strip below, thus adding to its fertility. As a result of this method the hillsides in many cases have the appearance of being slightly terraced.

On many of the slopes the influence of the more resistant sandy shales is very apparent, and a series of small natural terraces is found. The level part of each terrace is usually very productive soil, and the steeper part is kept in sod for the protection of the more productive lower lying slopes.

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Throughout the hilly sections of the area the character of the farm work is such that comparatively little barnyard manure is accumulated and placed upon the land. While generally speaking a comparatively small amount of commercial fertilizer is used, in some sections a considerable quantity is applied to the fields, particularly in growing wheat. Upon the bottom lands the best farmers use a great deal of manure, a large part of which they obtain from livery stables in nearby towns. On many of the first bottoms along the Ohio and the Little Kanawha rivers, as well as bordering the smaller streams, the productivity of the land is maintained by deposits of sediments from overflows.

Over quite a large part of the area the farmers seem to be in a prosperous condition. Most of the farmhouses are very well built and on many farms up-to-date machinery is used. This condition is, however, in part due to profits coming from oil and gas, for within recent years much wealth has accrued to the farmers from these two sources.

The demand for labor caused by the rapid development of business in connection with oil and gas is possibly the greatest drawback to farm work within the area. In many localities such high wages are offered by oil companies that it is well-nigh impossible for the farmers to obtain labor. From other localities many young men have been attracted to nearby towns, where they have shorter hours for work and better pay. Wages paid farm laborers vary from $15 to $30 a month, with board, lodging, and washing. In localities away from oil sections a common wage is $18 a month or 75 cents a day and board. One instance was noted on river bottom land where a laborer who was retained the year through was paid $18 a month, besides being furnished with a house, rough feed for a cow, cow pasture, a truck patch, and fallen fruits. During the busiest seasons of the year the daily wage is from $1 to $1.50 with board.

About 30 per cent of the farms of the area are leased to tenants, and these mostly on a share basis. On bottom lands when the owner furnishes merely the land he commonly receives one-third of the crop, but where he furnishes land, seed, work animals, and tools he receives two-thirds of the crop. The cash rental in the bottom lands is usually about 5 per cent of the taxable valuation, which ordinarily makes the rate from $3 to $9 an acre. In the upland sections if the owner furnishes only the land he commonly gets two-fifths of the crop. If he furnishes stock, such as cattle, sheep, and hogs, and one-half of the seed, he receives one-half of the grain and one-half the increase in the stock. The cash rental in the upland areas varies from 25 cents to $3 an acre.

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According to the census of 1900 the average size of farms within the area is about 87 acres.[a] According to the same authority the number of acres in farms in the entire area is 527,314, of which 304,451 acres is improved land. The average valuation per farm, including farm buildings, implements, machinery, and live stock, is about $2,200. Within the upland parts of the area land values ordinarily vary from $10 to $30 an acre. There are, however, some exceptions to these prices, depending upon location. The value of bottom land along the Ohio and Little Kanawha rivers is about $100 an acre, and of that along the smaller streams from $60 to $75 an acre. Oil and gas underlies a large part of the area, and on account of this values vary considerably. The prices stated, however, are based on agricultural value.

As the greater part of the Parkersburg area is well adapted to the raising of cattle and sheep, it would seem that many farmers within the area could very profitably increase their business in these lines. It is to be suggested also that more attention could well be given to the raising of both hogs and horses. On the rougher parts of the area goats should prove a very profitable investment. Whatever kind of stock is kept, it is furthermore to be suggested that pure breeds should be handled and that grades should as far as possible be eliminated. There are many good opportunities for the extension of dairying.

Several instances have been noted where draining the bottom lands by tiling has proved very beneficial. Careful attention should be given to this. Barnyard manure should not be allowed to accumulate, but should be distributed over the land as promptly as possible. Wherever the land is nearly level or gently rolling, the best method of doing this is by means of a manure spreader. One instance was noted where "floats" was used as an absorbent in the stable. This is an excellent practice.

In some sections of the bottom lands complaint is made that clover does not do well. Where this trouble prevails considerable care should be taken in selecting good seed and also in seeing that the lands are made alkaline through application of lime. During the past summer a fungus disease known as anthracnose of clover was noted. This disease affects the plant in the fall and in many cases causes it to winterkill. No remedy seems to be known except that of introducing a resistant variety, of which alsike and crimson clover are said to be among the best. Resistant strains of ordinary red clover have been developed by the Tennessee Experiment Station and the Bureau of Plant Industry of this Department.

[a] The average size in Wood County is about 75 acres, in Ritchie County 105 acres, and in Pleasants County about 80 acres.

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Comparatively few apples and peaches are grown within the area. Under normal conditions both of these fruits do well, and it would therefore seem that more attention could well be given to their production. To obtain the best results spraying should be practiced. Much of the roughest land within the area could be used to good advantage by carrying on systematic work in forestry; the growing of locust trees for posts, it is believed, would be especially profitable.

SOILS.

Eleven soil types have been recognized in the area, varying from a loose incoherent sand to a stiff heavy clay. In some cases the types pass very gradually into one another, so that it is difficult to define their limits, while in other cases the boundaries are very sharply marked. The greater part of the upland is not naturally of high agricultural value, although the soil in those parts of the area where the topography is less rough produces very good crops where properly managed.

The map accompanying this report represents the different types in colors; the following table gives the name of each type and its actual and relative extent:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Meigs clay loam	427,264	68.5	Wheeling silt loam	5,696	0.9
Rough stony land	59,456	9.5	Wheeling fine sand	2,624	.4
Dekalb silt loam	54,592	8.8	Brooke clay loam	1,856	.3
Huntington silty clay	40,832	6.6	Wheeling fine sandy loam	1,344	.2
Upshur clay	15,232	2.4	Wheeling gravelly loam	320	.1
Tyler silt loam	14,656	2.3			
			Total	623,872	

All of the upland of the area belongs to the Coal Measures of the Carboniferous period. The geological formations represented are the Dunkard (Permian), Monongahela, Conemaugh, Allegheny, and Pottsville. Passing from Belmont southward by way of Horseneck, Borland, Volcano, and Volcano Junction is an anticlinal fold locally spoken of as "the break."[a] It may be identified in many places along road cuts by the dip of the rock strata. Its width varies from 2 to 2½ miles. The principal formations represented within the area of the fold are the Monongahela, Conemaugh, Allegheny, and Pottsville. Outside of the area of the fold the principal formation is the

[a] The center of the fold is about three-fourths of a mile east of Volcano, 1 mile east of Volcano Junction, one-fourth of a mile west of Borland, one-fourth of a mile west of Horseneck, and at Belmont.

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Dunkard. The strata of all five of the series are made up of shales, sandstones, sandy shales, limestones, and coals, of which the first two are by far the most important from a geological standpoint.

The soils of the upland are formed mainly from sandstones and shales. Quite a large number of thick, massive sandstone rock strata occur throughout the area, but the extent of these is not sufficient materially to influence the soil. On some of the hilltops and narrow ridges the soil is somewhat lighter, though this characteristic is not sufficiently marked to warrant the establishing of a type. A very large proportion of the surface is of a silty character. Clay occurs in many small, irregularly shaped areas, either as a limestone soil or as derived from more or less calcareous red shales.

The most important soil in the upland, from point of extent, is the Meigs clay loam. There is only one type of the Dekalb series, the Dekalb silt loam, and it is very closely associated with Meigs clay loam. Two heavy types occur, the Upshur clay and Brooke clay loam, both of the Appalachian province. Rough, stony areas have been indicated as Rough stony land.

The soils of limestone origin are generally recognized as being strong and are especially well adapted to supporting permanent blue-grass pastures. They are also well adapted to the growing of wheat. The hilly upland soils derived from the shale and fine-grained sandstones are used mainly for pastures. Considerable damage is caused by landslides. Large areas of both soil and subsoil sometimes slide down to lower levels, and the frequent occurrence of these has tended to mix the soils, often giving rise to many variations within the same type. Erosion is also very active on these hillsides whenever the soil becomes exposed, and for this reason they should be kept either in sod or forest.

The bottom land along the smaller streams, as well as the first bottoms along the Ohio and Little Kanawha rivers, has been mapped as Huntington silty clay. This type is frequently overflowed and is being formed from the deposition of materials washed from the adjoining hills and from the drainage area of the Ohio River to the northeast.

Along the course of the Ohio River are four members of the Wheeling series—Wheeling silt loam, Wheeling fine sandy loam, Wheeling gravelly loam, and Wheeling fine sand. The first three of these are locally known as river-bottom land, and in many cases occur in well-formed terraces. Beginning with the Huntington silty clay, which is known as first bottom, the other terrace levels above are known as second and third bottoms. The vertical distance between the levels of these terraces varies from 15 to 25 feet. It is very evident from the character and position of these terraces that they were formed of materials transported from long distances

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to the northeast when the current of the river was much swifter and when it flowed at a much higher level than it does at present. The Wheeling fine sand occurs at an intermediate position between the terraced bottom lands and the upland. The origin of this type of soil is very similar to that of the other members of the series, but it has been somewhat modified by the action of wind. The types of the Wheeling series are rarely overflowed. A good condition of drainage usually exists over these types, and this is generally true of the Huntington silty clay.

Of all the soils within the area those along the river are the most valuable for farming. The Huntington silty clay is the strongest soil, but somewhat undesirable because of overflows. In the uplands the best soil for farming purposes is the Dekalb silt loam. The Brooke clay loam and Upshur clay are strong productive types, but are very difficult to work. The Meigs clay loam is best adapted to grazing.

MEIGS CLAY LOAM.

Locally the Meigs clay loam is quite often spoken of as "slaty land" or "gravelly land." It is closely associated with the Dekalb silt loam. The soil to a depth varying from 2 to 6 inches is usually a reddish or yellowish gray to a grayish-brown silt loam to heavy silt loam, containing numerous fragments of yellowish or grayish-yellow shale or shaly sandstone. These do not interfere with cultivation. On small hillsides and narrow ridges the soil is quite often somewhat lighter in texture, due to the more sandy character of the underlying formations. The subsoil to a depth varying from 10 to 20 inches is usually a yellowish silt loam to clay loam, below which is found a clay loam to clay varying in color from yellowish to mottled yellow and red. In other instances the subsoil throughout its entire profile of 36 inches may be a yellowish-red, reddish-yellow, or mottled red and yellow clay loam to clay. In some instances also red clay occurs in the lower part of the profile at depths varying from 24 to 36 inches. Rock fragments of shaly character are usually found through the entire subsoil, and bed rock occurs at depths varying from about 20 inches to 5 feet, the depth depending upon the amount of erosion which has taken place. Another characteristic of the soil is that it very often contains a marked content of coarse sand.

The Meigs clay loam occurs very irregularly in practically all parts of the area and has the largest extent of any type surveyed. Throughout the type are many areas of Upshur clay and Brooke clay loam too small to be mapped. Over some parts of it its topography is gently rolling enough to permit of cultivation and in such cases a good tilth is easily obtained. In general, however, the

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surface is rough and very hilly, and a large part of it occurs as steep hillsides, on which erosion is very active if not checked. Drainage is excessive over the greater part of the soil. The underlying rocks are usually from 2 to 5 feet beneath the surface and for this reason the type is very likely to be droughty. Much damage through erosion often results in tilled fields, even though contour cultivation is practiced. It is on this type, almost wholly, that the landslides previously spoken of occur. These take place usually during rainy weather when bodies of both soil and subsoil, varying in size from a few square rods to several acres, slip down the hillside, ordinarily for a distance of about 20 feet. In many instances, however, they slide much farther than this. As a result the soils coming from the disintegration of the different underlying rock strata become very much mixed and many variations therefore occur which can not be mapped on the scale used. Many small streams and runs occur through the Meigs clay loam areas, giving good surface drainage conditions.

The Meigs clay loam is derived from the shales and soft sandstones and sandy shales of the Coal Measures, principally of the Dunkard series. A very constant feature of the type is the presence of many small shale and standstone fragments.

The principal object in bringing this type of soil under cultivation is to obtain pasture. It is not naturally strong, but fairly good yields are obtained. Corn, wheat, and hay are the principal crops. Corn produces from 15 to 35 bushels per acre, with an average of about 20 bushels; and wheat from 6 to 20 bushels per acre with an average of about 10 bushels. Hay yields about three-fourths ton per acre. Fruits, such as apples and peaches, do well; and the same is true of small fruits, such as strawberries and raspberries.

By far the greater part of the Meigs clay loam is best adapted to pasture. Where the topography is very steep no clean tillage crops are produced, but pasture is at once obtained through the methods discussed on page 16 of this report. Bluegrass is best for pasture purposes. In some localities it occurs as a natural growth, while in others means are taken for introducing its growth. Bluegrass seed is often sown with clover on wheat ground in the spring. Hay is taken from the field the year following the wheat crop, after which it is used for pasture. The bluegrass usually takes possession of the field gradually and within three or four years a good pasture is generally obtained. One method of starting a pasture and one which has given good results in other sections is the following: In the fall, usually in September, a good seed bed is prepared in which a mixture of redtop and timothy is sown. After this small bluegrass sods are dropped over the field about 6 feet apart each way. These take root and spread, and in the following spring clover is sown. A crop of hay is

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cut each succeeding season as long as the field produces a satisfactory crop and afterwards it is used as bluegrass pasture. When the bluegrass runs out, the fields are sometimes plowed again for the purpose of growing corn, wheat, and hay, and with the idea of eventually reseeding to pasture. Where there has been difficulty in obtaining a good growth of bluegrass, it is suggested that an application of lime and some form of phosphate might remedy the difficulty. The Meigs clay loam as a rule should not be cultivated to general farm crops, but should be used for pasture or for fruit. It would seem that the raising of grapes might prove profitable.

The original timber growth upon this soil was largely oak, maple, walnut, hickory, and poplar. At present it is principally locust, oak, hickory, walnut, and poplar. It is suggested that locust for posts might prove profitable upon this type. The price of this land ranges from $10 to $25 an acre.

The following table gives the results of mechanical analyses of fine-earth samples of the soil and subsoil of this type:

Mechanical analyses of Meigs clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19224	Soil	1.2	2.7	0.8	1.3	13.5	60.1	20.4
19225	Subsoil	.8	3.0	1.0	2.4	5.6	51.9	35.1

DEKALB SILT LOAM.

The soil of the Dekalb silt loam, to a depth of about 9 inches, is a grayish to grayish-brown fairly compact silt loam, the particles of which feel very smooth between the fingers. The subsoil, to a depth of 36 inches, is ordinarily a yellow compact silt loam to clay loam, becoming heavier as depth increases. The latter description does not, however, apply to the subsoil in all parts of the area. In some instances the color becomes a reddish yellow to yellowish red in the lower parts of the profile. In others the subsoil to a depth of about 15 inches is a yellow compact silt loam, from which depth to about 25 inches it is of the same color but heavier. From 25 inches to 36 inches it is quite often lighter in texture and of a mottled gray and reddish-yellow color. Heavy red clay sometimes occurs in the lower subsoil and in parts of the type near areas of Upshur clay it is even found at depths varying from 15 to 20 inches. The areas last mentioned are not of large extent and were therefore not mapped as a separate type. Only a comparatively small quantity of fragments of sandstone and sandy shale are found over the surface or in the soil and subsoil.

The largest and most typical area of Dekalb silt loam is found in the western part of the survey southwest of Parkersburg. Other quite

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extended areas are located south of Williamstown, Waverly, and Salama. The soil also occurs quite typically developed around Cairo, Harrisville, and Pennsboro. For the most part the type has a gently rolling topography and is easily cultivated. In some places it occurs as nearly flat or gently rolling hilltops, but in others the topography is quite sharply rolling. It is well supplied with streams, which results in good surface drainage conditions. Over some of the most gently rolling parts of this type it is thought that soil conditions could be materially improved by tiling. The areas of this soil are seldom damaged by erosion.

The Dekalb silt loam is a residual soil coming from the weathering of the shales and shaly sandstones of the Coal Measures, mainly of the Dunkard series. In road cuts the underlying rock is usually seen at depths varying from 4 to 6 feet. It is of the same character as that found at the lower depths within the areas of Meigs clay loam. The sand constituent of these rocks influences the soil considerably less than might be expected.

A very large percentage of the type is at present under cultivation. It is, however, not especially well adapted to any particular crop, but when well handled it is a good soil for the general farm crops. It is a soil responsive to good treatment and sensitive to neglect. Corn yields from 15 to 25 bushels per acre, wheat from 10 to 25 bushels, potatoes from 100 to 175 bushels, and in good years hay about 1½ tons to the acre. Oats are grown to some extent and ordinarily yield about 25 bushels per acre. In some sections near local markets tomatoes are profitably grown. Apples and peaches and also small fruits, such as strawberries and raspberries, do well.

Some commercial fertilizer is used, being usually sown with the wheat crop. As much organic matter as possible should be added to this soil and to accomplish this end the crops grown should be kept and fed to stock with a view to producing as much manure as possible. It is thought that the application of lime would increase the productivity of the soil.

The original forest growth was mainly white oak. The principal forest trees now are oak, walnut, and hickory. The type has a value ranging from $15 to $30 an acre.

The following table gives the results of mechanical analyses of fine-earth samples of the type:

Mechanical analyses of Dekalb silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19208	Soil	0.1	1.7	3.3	11.1	3.5	66.7	13.3
19209	Subsoil	.3	1.1	3.0	12.3	8.4	55.1	19.6

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UPSHUR CLAY.

The soil of the Upshur clay is an Indian red or reddish-brown clay or clay loam varying in depth from 2 to 5 inches, through which small limestone fragments are occasionally found. In some parts of the type small limestone concretions are quite common in the soil. The subsoil is usually a heavy, tenacious red clay, but may sometimes be slightly mottled gray and yellow. There is generally but slight difference between the texture of the soil and subsoil.

The type is a very difficult one to handle on account of its tough and tenacious character. Both soil and subsoil often become cracked, the cracks varying in size from one-fourth to three-fourths of an inch and extending downward in many cases to a depth of over a foot. During wet weather the roads over this soil form into a deep red mud, through which it is well-nigh impossible to travel. During dry weather they are very rough until smoothed down by travel or by the use of road machines.

The Upshur clay is found mostly in the western and southwestern parts of the area. It is most typically developed in the southwestern part. Its topography is generally quite steep, but in some cases it occupies gentler slopes. In other instances it occurs as narrow bands extending along hillsides, due to the horizontal outcrops of the rocks from which the soil is derived. The surface drainage is very good, but where the soil is unprotected it is likely to erode badly.

The soil is derived from the more or less calcareous red shale of the Coal Measures. In some places small iron concretions occur. In many parts where neither limestone fragments nor concretions are to be found the soil is calcareous in character, as is proved by effervescence on applying hydrochloric acid. In quite a large number of instances land slides have mixed the type with Meigs clay loam, thus producing a phase somewhat poorer in character.

With proper handling Upshur clay produces very good crops of wheat, corn, and hay, but it is too heavy for potatoes or truck. It is best adapted to wheat and for bluegrass pasture. Oats are grown to some extent. Apples and peaches seem to do well, as do also small fruits. Wheat produces from 10 to 20 bushels, and corn from 30 to 60 bushels per acre. Hay yields 1½ to 2 tons and oats about 25 bushels per acre.

The most undesirable feature of the Upshur clay is the difficulty in cultivating it. During dry weather it has a tendency to bake and becomes very difficult to handle, except in areas that are somewhat loamy. When plowed in the fall winter rains have a tendency to cause the soil to run together or pack, thus making it difficult to prepare a good seed bed in the spring. This may be overcome to some extent by having the ground plowed in sod. If plowed in the spring it is likely to clod and bake badly. The best method of handling the

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type seems to be to plow it late in February or early in March, after which it is subjected to alternate freezing and thawing which tends to make it loose and mellow, which condition is of material help at the time of preparing the seed bed.

The greater part of the soil has been cleared for cultivation. The principal trees found on it are hickory, locust, and walnut. The value of the land varies from $25 to $35 an acre.

The following table gives the results of mechanical analyses of the fine-earth samples of this soil type:

Mechanical analyses of Upshur clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19238	Soil	0.0	2.5	0.7	4.9	3.9	48.4	40.3
19239	Subsoil	.3	.8	.4	8.5	15.0	48.3	27.1

BROOKE CLAY LOAM.

The soil of Brooke clay loam is a dark-gray clay loam varying in depth from 3 to 5 inches. The subsoil under most typical conditions is a heavy yellowish-gray clay. In some cases, however, it is a heavy yellowish-brown clay to clay loam to a depth of about 16 inches, below which occurs a mottled yellowish-brown, reddish-brown, yellowish-gray, or ashy-gray material. The yellowish-gray and ashy-gray subsoils are inclined to be quite friable when dry. The red coloring is most prominent in the lower part of the profile. Scattered over the fields and disseminated through both soil and subsoil are grayish or bluish colored limestone fragments. A considerable number of limestone bowlders are also scattered over the fields and similar rounded stones are often encountered in boring. Cracks varying in width from one-fourth to three-fourths of an inch often extend downward through both soil and subsoil in practically the same way as in Upshur clay. As regards cultivation the type is very similar to Upshur clay. If plowed when too wet or too dry it becomes very difficult to handle, but if plowed in the right condition it not only turns much more easily but may be cultivated later with much less difficulty. As with Upshur clay, it is found that the best time to plow the soil is in February or March, so that it may have the beneficial effect of later alternate freezing and thawing. If plowed in the fall it is very likely to become packed by the time a seed bed is to be prepared.

The type occurs only in small, irregularly shaped bodies in the southwestern part of the area in Wood County, and is seldom found at elevations below 1,000 feet. In many instances it is so closely

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associated with Upshur clay that it is difficult to draw a line of separation between the two types.

The Brooke clay loam is derived mainly from the disintegration of limestone, but to a slight extent may also come from the weathering of calcareous shales. It practically always occurs on hilltops or ridges. The drainage is good and in very few instances is it found to be eroded. The absence of eroded areas is very largely due to the fact that it is generally kept in pasture. The soil absorbs and retains moisture well and this causes the pasture to be much more permanent than upon the lighter Meigs clay loam.

The type is considered one of the best hilly upland soils. It is well adapted to the growing of general farm crops and is quite easily kept in a good state of productiveness. Bluegrass pastures upon this type are especially good. The principal crops grown are wheat, corn, hay, and oats. Apples and peaches and also small fruits, such as strawberries and raspberries, do well. Few potatoes are grown. Wheat yields about 20 bushels per acre, corn about 45 bushels, oats about 30 bushels, and hay ordinarily 2 tons to the acre. Clover nearly always makes an excellent growth upon this soil.

Practically all of the type is cleared land and is used mainly for bluegrass pasture. When cultivated as much manure as possible should be applied, since it will serve the double purpose of increasing the productiveness of the soil and improving its physical condition. The land has a value of about $30 an acre.

The following table shows the average results of the mechanical analyses of a sample of the soil and subsoil of this type:

Mechanical analyses of Brooke clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19226, 19228.....	Soil.....	0.1	5.3	1.9	8.3	3.8	46.3	33.9
19227, 19229.....	Subsoil.....	.0	2.1	1.7	8.9	4.9	44.3	37.6

HUNTINGTON SILTY CLAY.

The Huntington silty clay includes all of the areas along the Ohio and Little Kanawha rivers known as "first bottom land" and all of the bottom land along the smaller streams throughout the area. The soil is a compact brown silty loam to silty clay loam, usually having a depth of about 12 inches. The subsoil to a depth of 36 inches is a somewhat lighter brown, compact, rather heavy silty clay to clay loam. In some areas, however, the subsoil is sometimes lighter in texture in the lower depths; and along the narrow bottoms of the smaller streams it quite often happens that both soil and sub-

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good crops. An application of lime would also very likely prove beneficial.

The farmers upon this type of soil are the most prosperous of any within the area and their holdings almost always include both first bottom land and hill land. Taken as a whole their farms are considered to be worth from $80 to $125 an acre. When considered separately the Wheeling silt loam is valued at $100 to $150 an acre.

The following table gives the results of mechanical analyses of this type:

Mechanical analyses of Wheeling silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19254	Soil	0.0	0.7	0.4	6.0	17.4	61.1	14.1
19255	Subsoil	.0	.5	.3	8.6	24.7	46.0	19.2

WHEELING GRAVELLY LOAM.

The soil of Wheeling gravelly loam is a brown gravelly loam having a depth of about 10 inches. The fine-earth content is a loose, rather coarse sandy loam. A considerable quantity of gravel is found on the surface, forming probably from 30 to 60 per cent of the soil mass. The fragments, which consist of granite, quartz, quartzite, and sandstone, vary in size from one-eighth of an inch to more than an inch in diameter, and are usually well rounded. The subsoil is very similar to the soil, except that the fine-earth portion is slightly lighter in color. The gravel is of the same character and occurs in such quantities that it is almost impossible to make an auger boring. Although the gravel content of the soil is high, it offers no serious difficulty to cultivation.

The Wheeling gravelly loam is confined to the terraces along the Ohio River, and occurs in only a few small areas near Williamstown and St. Marys. It has a level to very gently rolling topography with an elevation of about 70 feet above the river. Owing to its loose open texture both the surface and underdrainage are always good.

This is a sedimentary soil made up of reworked glacial materials carried by the river from a considerable distance to the northeast, when its current was much stronger and its volume much larger than at present. During the ages since the deposition the surface has been more or less modified by weathering and the addition of organic deposits. Gravelly material of the same character as that of the Wheeling gravelly loam is often encountered in digging wells on the Wheeling silt loam, a type which occurs at nearly the same level as the Wheeling gravelly loam.

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As found in the Parkersburg area the soil is used mainly for growing garden vegetables. It is especially adapted to tomatoes and watermelons. Wheat ordinarily yields from 10 to 25 bushels and corn about 45 bushels per acre. Potatoes yield about 100 bushels per acre. Barnyard manure is practically the only fertilizer used. Land of this type of soil has a valuation of from $75 to $100 an acre.

The following table gives the results of mechanical analyses of fine-earth samples of the Wheeling gravelly loam:

Mechanical analyses of Wheeling gravelly loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18932	Soil	4.9	33.4	17.2	7.2	5.7	23.6	8.1
18933	Subsoil	2.9	48.6	22.3	9.7	1.5	6.1	9.2

TYLER SILT LOAM.

The soil of Tyler silt loam is grayish to grayish-brown silt loam having a depth of about 9 inches. The subsoil to a depth of about 20 inches is a yellowish or mottled yellow and gray silt loam which is quite often rather heavy in character. From 20 to 36 inches it is ordinarily a mottled brownish-yellow and gray silt loam to clay loam, and this is sometimes slightly lighter in texture from 30 to 36 inches. In other cases the subsoil is a clay loam to clay of dark-gray and dark-yellowish mottled color.

The Tyler silt loam occurs as second bottom land along the larger tributaries of the Ohio River, at elevations varying from 15 to 100 feet above water level, and is never overflowed. Its largest areas are found along the Little Kanawha River. The topography varies from level to gently rolling, and the drainage is fairly good in the more rolling areas and deficient in those that are level or nearly so.

The type is alluvial material laid down in early ages when the streams along which it occurs were of much greater volume and, in many places, much wider than now. A little material washed from the adjoining hillsides has been incorporated in this soil.

Considered only fairly good farming land, much of the Tyler silt loam is used for pasture. Corn and hay are the principal crops, the former yielding from 35 to 50 bushels per acre and the latter about 1¼ tons per acre. Wheat and oats are very little grown.

On many areas where the topography is level or slightly rolling underdrainage would undoubtedly improve the condition of the soil. Applications of lime would also prove beneficial. As much organic material as possible should be added to the soil, through the application of manure and the plowing under of cover crops, such as rye, crimson clover, or hairy vetch.

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ROUGH STONY LAND.

Rough stony land includes all of those areas which are so rough and stony as to be of very little value from an agricultural standpoint. The soil generally resembles the Meigs clay loam, but in some cases it is somewhat more sandy than that type. Rough stony land is found in nearly all parts of the area and generally occurs on the steep hillsides along stream courses. In a great many instances massive rock outcrops, which are generally those of sandstone, may be seen, and below such outcrops large, irregularly shaped bowlders often occur in large numbers. For the most part it is covered with forest. Over a large part of the type the topography is so steep as to make it impracticable to use it for either orchard or pasture.

SUMMARY.

The Parkersburg area is located in the northwestern part of the State of West Virginia and comprises the counties of Wood, Pleasants, and Ritchie—an area of about 956 square miles. The topography of the area varies from rather gently rolling to rough and hilly, the greater part of it being of this latter character.

The country districts of the area can not be said to be very thickly populated. The largest town is Parkersburg, which has a population of about 22,000. It maintains several large manufacturing plants and is the center of a large jobbing and retail trade. St. Marys is the next town in size and has a population of about 2,000. Other smaller but thriving towns in the area are Bellville, Cairo, Harrisville, and Pennsboro.

One of the most important industries is that of obtaining petroleum. It is and has been a very material help to the farmers, but, at the same time, it has attracted attention away from agriculture.

The main line of the Baltimore and Ohio Railroad, its Ohio River division, and the Zanesville branch of the Baltimore and Ohio Railroad afford excellent means for transportation of products to all of the distant markets. In the eastern part of the area, in Ritchie County, are the Cairo and Kanawha Railroad and the Lorama Railroad, both of which are short lines connecting with the main line of the Baltimore and Ohio. Extending to the southeast along the little Kanawha River into Wirt County is also the Little Kanawha Railroad. Packet boats ply both the Ohio and Little Kanawha rivers, except at times of low water.

The most important agricultural products of the area are beef and wool. Veal and mutton are also produced to a considerable extent. The main farm crops are corn, wheat, potatoes, and hay. These with some truck and fruit about complete the list of agricultural products.

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The climate is healthful and well suited to farming. The average annual temperature is about 53° F. The average for the two coldest months is about 33° F., while that for the two hottest months is about 74° F. The temperature seldom reaches 100° in summer or the zero point in winter. The rainfall has an annual average of about 43 inches, and the greatest precipitation usually takes place during June and July, when it is needed for growing field crops.

Eleven types of soil occur in the area. Six of them are of alluvial origin, while the remaining five are residual, derived from the Coal Measures of the Carboniferous period.

The Dekalb silt loam is the most valuable upland type. When well handled it produces good crops of corn, wheat, and hay. Potatoes and oats are grown to some extent. Apples and peaches and also small fruits such as strawberries and raspberries do well. The type has a value ranging from $15 to $30 an acre.

The Meigs clay loam is the most extensive type in the area. In general it is very rough and hilly. A large part of it occurs as steep hillsides on which erosion is very active. The type is used mainly for pasture. The main crops grown are corn, wheat, and hay. Apples and peaches and small fruits do well on this type. It has a value ranging from $10 to $25 an acre

The Upshur clay is a very heavy red clay in which limestone fragments are occasionally found. It usually occurs on steep hillsides and hilltops, and because of this and its very heavy character it is quite difficult to cultivate. The crops usually grown are wheat, corn, and hay. It is a very good wheat soil. Some oats are grown. Apples and peaches both do well. The value of this type ranges from $25 to $35 an acre.

The Brooke clay loam is a gray limestone soil, usually occurring on ridges or hilltops. Large limestone bowlders are found on the surface. The type is used mainly for bluegrass pasture. Although it is difficult to work, it is a strong soil for general farm crops. Only a small amount of this soil occurs in this area.

The Huntington silty clay is the first bottom land occurring both along the Ohio and Little Kanawha rivers and the smaller streams of the area. It is subject to overflow, but it is nevertheless considered to be valuable farming land. The crops to which it is best adapted along the rivers are corn and hay. Along the smaller stream courses potatoes and garden vegetables are also very successfully grown. The type is worth from $75 to $150 an acre.

The Wheeling silt loam is another valuable bottom-land type, occurring in terraces along the Ohio River. Its topography is level to gently rolling, and it is everywhere easily cultivated. Wheat, corn, potatoes, and hay are the principal crops. Garden vegetables and

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The surface features of the county are characteristic of a glacial region. The topography generally varies from level to gently rolling, though there are considerable areas of broken and hilly land. Bluffs ranging from 50 to 200 feet in height are found along the Manistee River, the highest occurring in Springville, Wexford, and Hanover townships. Broken and hilly sections are found in the eastern and southern parts of Cedar Creek Township, the northern and eastern parts of Haring, the northern part of Selma, the northern and western parts of Boon, the eastern part of Slagle, the central part of Henderson, and the eastern part of Clam Lake townships. The roughest part of the county is north of Harriette in Springville and Antioch townships. The elevation of Black Briar Hill is about 300 feet above the general level of the county. An extensive level area lies directly north of Cadillac and extends through central and southern Selma, part of Boon and Henderson, and the greater part of Cherry Grove townships. The northeastern corner of Wexford Township is level, as is also a large strip along the Manistee River in Greenwood and Liberty townships. Through this level or undulating country the river has cut a deep channel. The streams, the hills—though they do not occur in continuous ranges—and the soil types have a tendency to follow lines parallel with the course of the glacier which traversed this region in a northeast-southwest direction.

The drainage of the county is into the Manistee and Muskegon rivers. The Manistee River crosses the area from northeast to southwest. It enters the northeast corner of Liberty Township and leaves the county in the southwest corner of Springville Township. The northern half of the county drains directly into this river through small branches. The southwest corner is traversed by the South Branch of the Manistee River, which unites with the latter in Manistee County. The southeast quarter of the county drains into Lake Mitchell and Lake Cadillac, thence through Clam River into the Muskegon River in Clare County. Both the Manistee River and the South Branch have sufficient fall to afford valuable water power, but at present no use is made of this within Wexford County.

The first settlement was made in Wexford Township in 1863. The county was organized in 1869, being formed from a part of Manistee County. As first organized it included territory which was later cut off to form Missaukee County. Many of the residents are from Norway, Sweden, and Germany. Within the last few years Ohio, Indiana, Illinois, and southern Michigan have contributed to the inflow of settlers. The population in 1870 was 670, in 1880, 6,815, in 1890, 11,218, in 1900, 16,845. Slagle, Boon, South Branch, Henderson, Liberty, and Greenwood townships are the most thinly settled

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and the least developed portions of the county. The population throughout the remainder of the county is quite evenly distributed.

Cadillac, the county seat, was incorporated in 1877 and was formerly called Clam Lake. It has a population of about 9,000, is the chief town of the county, and is probably the leading business place in northern Michigan. It is located in the southeastern portion of Wexford County, at the junction of the Grand Rapids and Indiana and the Ann Arbor railroads, and is 97 miles due north of Grand Rapids, Mich. It has all modern improvements and is the site of a number of manufacturing plants. Cadillac has always been a great lumber center, but at present agriculture is coming to the front, and the city is becoming a distributing point for all agricultural supplies and a market for all the farm products. Manton, with a population of about 900, is a thriving town in the northeastern part of the county in Cedar Creek Township. It is surrounded by good farming land and ships considerable quantities of farm produce. Gilbert, Yuma, Harriette, Mesick, Sherman, and Buckley are towns of less importance.

Wexford County is well supplied with railroads. The Grand Rapids and Indiana, built in 1870, crosses the eastern side of the county from north to south and the Ann Arbor from southeast to northwest. The Manistee and Northeastern traverses the northwest corner of the county.

The wagon roads are naturally sandy, but there is plenty of gravel in the county with which to make improvements. Many miles of road are graveled, and more work of this character is being done each year.

Cadillac and the small towns throughout the county afford a limited market for farm produce. The bulk of the potato crop is shipped to Southern States. Produce buyers are located in the various towns during the shipping season.

CLIMATE.

The following table, compiled from the records of the Weather Bureau station located at Ivan, in Kalkaska County, shows the normal monthly and annual temperature and precipitation, the absolute maximum and minimum temperature and precipitation, and total precipitation for the wettest and driest years.

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industrious success has been attained, as is evidenced by a few good farmhouses and substantial barns in each community.

Up to the present time settlement has been mainly on the hardwood land. Thousands of acres of this land cleared of timber can be bought from $5 to $15 an acre. The pine stump land is more difficult to clear than the hardwood land. If the land is allowed to lie a few years after the removal of the timber before attempting to remove the stumps it is more easily cleared, as the dry stumps are readily burned.

The present methods of farming are much better than those previously followed, though there is still considerable room for improvement in regard to seed selection, rotation of crops, and building up and maintaining the soil fertility.

In the cultivation of sandy soil, such as forms 97.5 per cent of the area of the county, it is advisable to plow shallow. On the Pine plains and Pine hill phases of the Miami sand a depth of 4 inches is sufficient, while on the Hardwood land phase the soil can be plowed perhaps 2 inches deeper. The reason for shallow plowing is that the amount of organic matter is limited to the first 2 or 3 inches; sometimes it is almost entirely lacking. If the land is plowed, say, 8 inches deep, all of this vegetable matter is buried, so that the young plants are not fed by it and do not get the thrifty start they should have. As a rule there is more organic matter in the Hardwood land phase, and therefore it can be plowed deeper than the pine land.

When land is cleared in the spring it is best not to plow until midsummer, since by that time there will be a good growth of weeds, grass, and other vegetation which when turned under will add considerable vegetable matter to the soil. The roller should be used freely to pack the soil, though it is advisable to follow the roller with a light harrow to make a surface mulch. This not only prevents evaporation and thus retains the soil moisture for the use of crops, but it also leaves the surface of the field slightly roughened and this reduces drifting and blowing out of the seed.

The chief money crop of the area is potatoes. In 1903 there were 5,426 acres planted to potatoes and a yield of 584,509 bushels was secured. The soil is well adapted to this crop, and where special attention is given to its cultivation exceptional yields are obtained. Occasionally a man will be found who has paid for his farm from the first crop of potatoes. The average annual shipment of potatoes from Cadillac is 450 cars of 650 bushels each. Potatoes are also shipped from other points in the area.

Corn is not especially adapted to the soil and climatic conditions. Both the dent and the flint varieties are grown and mature. Special attention should be given to developing a strain better adapted to existing conditions. In 1903 the acreage planted to corn was 6,093 acres with a yield of 137,354 bushels.

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Oats are grown to some extent, but the soil is too light to give the best yields. The same is true of wheat. In 1903, 5,101 acres were in oats and 3,298 acres in wheat, yielding 142,093 and 46,630 bushels, respectively.

Some rye and buckwheat are also produced. These crops do very well and are frequently grown as green manuring crops.

A stand of clover can usually be secured without difficulty. It is best to seed in the spring without a nurse crop.[a] In 1903, 5,560 acres were in clover, the yield averaging more than 1 ton per acre. The acreage of timothy was 9,175 acres, with a slightly lower yield. Alfalfa will grow here, and a few plants were found which had matured seed. It withstands the winter fairly well, being protected by deep snow. It is probable that a strain could be developed which would flourish in this region.

Cucumbers have been grown to some extent and when properly cultivated the yields are satisfactory. There are several pickle factories in the county.

Beans and pease are grown with fair success. Truck crops, such as cabbage, tomatoes, onions, beets, strawberries, and melons, are produced, but the supply does not equal the local demand.

The fruit industry has not been developed to any extent, but it has been demonstrated that the hardy varieties of apples, pears, grapes, and cherries will do well. Their color and quality are good. Peaches are not a success, as Lake Michigan, which is about 24 miles distant from the extreme western part of the county, does not modify the climatic conditions to a noticeable degree.

No definite system of crop rotation is followed. It is customary to plant potatoes on new ground for one or two years, and to follow this crop with corn. The land may then be seeded down and hay cut for one or two years, and after the sod is plowed potatoes are usually planted again. Fall wheat or oats may follow corn. Seeding is sometimes done at the time the oats are sown or the grass may be sown without a nurse crop. In old fields, where the yields have declined, rye and buckwheat are occasionally plowed under before planting potatoes.

Comparatively little live stock is kept. Cattle are allowed to range through the woods and cut-over lands. There are a few thoroughbred cattle, but most of the stock is of mixed blood. The dairy industry could be readily extended by making greater use of soiling crops and growing more ensilage. There are only a very few silos at present. A few sheep are kept, but the number could be increased, as there are large ranges over which they could feed. Each farm has a few hogs, but they are not raised extensively.

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[a] Farmers Bulletin No. 323, U. S. Dept. Agr.

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Little difficulty is experienced in securing farm labor. Laborers get from $20 to $25 a month, with board, or from $1 to $1.50 a day during potato digging or harvest time. Many who work in the woods in winter go to the farms in summer. The wage in the mills is from $1.75 to $1.85 a day for ordinary labor, and in the woods from $26 to $28 a month, with board.

The Michigan census for 1904 states that there were 1,475 farms in the county, 91 per cent of which were operated by the owners, and the number is annually increasing. The average size of a farm is about 80 acres. The little renting done is on shares, the tenant furnishing everything and taking two-thirds of the crop. However, the ownership of land is easily acquired. Farms may be purchased on installments, and when a stipulated amount has been paid a deed is given and a mortgage taken for the balance due. Hardwood stump land brings from $5 to $15 an acre. When partially improved it sometimes sells as high as $40, depending, of course, on the location. Pine stump land can be bought from $2.50 to $10 an acre.

As means to improve the general agricultural conditions of the county, it is suggested that more live stock should be kept, dairying increased, and soiling practiced to a greater extent. The soil and climatic conditions seem well adapted to the production of clover seed, which may be grown upon new lands that would not bring profitable yields of the grains or potatoes, the land improving from year to year and finally becoming well suited to general farming. It is recommended that the plowing under of green manuring crops, such as clover, rye, and buckwheat, should be more generally followed and that a systematic crop rotation should be substituted for the present irregular succession of crops. More attention given to seed selection will also improve conditions. It will also pay to give the crops more careful cultivation than at present. It is believed that the production of apples, pears, and grapes could be extended with profit.

SOILS.

The soils of Wexford County are derived from the mantle of glacial débris which covers to a great depth the southern peninsula of Michigan. While this material has been modified to a greater or less extent by erosion, by the action of wind, and by the growth and decay of vegetation, the surface material giving rise to the soil types is much more uniform throughout this county than in many other sections of the State. The underlying rocks have been covered to a depth of from 100 to several hundred feet and have had no influence whatever on the formation of the surface soils. The glacial material, which was originally derived from the breaking down of metamorphic and igneous rocks, was transported long distances by

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the glacier and deposited as ranges of hills, rolling areas, or level stretches of land.

With the exception of a few square miles, the soil of Wexford County consists of one type—the Miami sand, an important member of the Miami series, which embraces the upland timbered regions of Michigan, Wisconsin, Ohio, Indiana, Illinois, Iowa, and Minnesota. As found in Wexford County this soil occurs in three phases. The Clyde series, a group of soils found in old lake beds and reclaimed swamps, is represented in the county by one type, the Clyde clay loam, of which there is less than one-half square mile. There is about four times this area of Dunkirk clay loam and a much larger though relatively small area of Muck.

The following table gives the actual and relative extent of the soil types mapped in the Wexford County area:

Areas of the different soils.

Soil.	Acres.	Per cent.
Miami sand	357,120	97.5
Muck	7,744	2.1
Dunkirk clay loam	1,152	.3
Clyde clay loam	256	.1
Total	366,272	.....

MIAMI SAND.

Hardwood land phase.—The soil of this phase of the Miami sand to an average depth of 6 inches consists of a brown or grayish slightly loamy sand of medium texture. The amount of organic matter present varies considerably, the larger proportion being usually found in fields which have been under cultivation for a number of years and in which crops of rye or clover have been frequently turned under. In some areas of virgin soil leaf mold has added a relatively large quantity of organic matter to the soil, but its occurrence is not uniform, as forest fires from year to year burn off the leaves and grass, leaving only a little ash to be incorporated with the soil. As a rule, the amount of fine material and organic matter present is small, and the soil is loose, open, and very easy to cultivate.

The subsoil to a depth of 36 inches, and often to a depth of 4 to 8 feet, consists of a dark-brown or yellow sand, which becomes lighter in color as the depth increases. There is a smaller percentage of fine material in the subsoil than in the soil. On the surface, and mixed with both soil and subsoil, there is a small percentage of glacial gravel. In many places gravel beds are found within 3 feet of the surface, usually occurring in small knolls or on the sides of hills. Some stones and a few bowlders are scattered over the surface, but

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not in sufficient numbers to interfere with cultivation. The only section in which stones occur to any considerable extent is in the southeastern corner of the county, in the eastern half of Clam Lake Township. This area has been indicated on the soil map by means of symbols.

At frequent intervals throughout this soil small areas of clay outcrop or lie close to the surface. These areas are often only a few rods in extent, but where large enough they are mapped as Dunkirk clay loam. In other places the fine material from the underlying clay seems to have become mixed with the overlying soil, which gives it more compactness and sufficient coherency to stand up in road cuts. In such places the soil is more retentive of moisture and slightly more productive, but as the areas of this character are comparatively small no attempt was made to show them as a distinct type.

The Miami sand (Hardwood land phase) covers by far the greater part of Wexford County. The largest continuous area comprises most of Colfax, Selma, Boon, Antioch, Springville, and Wexford townships.

The surface varies from level to broken and hilly, the major portion being gently rolling. An extensive level strip is found in the vicinity of Yuma and extending to the south. The northeast portion of Wexford Township is also level. Other smaller stretches of level land are scattered throughout the type. The roughest area lies between Harriette and Mesick, in Springville and Antioch townships. A very pronounced range of bluffs extends along the north bank of the Manistee River across Springville and the southeast corner of Wexford townships. Other broken areas are also found throughout the county.

Owing to the character of the topography and the loose, open nature of the soil and subsoil, the natural drainage is good and only in a few depressed areas is artificial drainage necessary.

The material composing the Miami sand in its several phases is glacial débris, though the texture of the Hardwood land phase is more uniform than is usually the case with glacial deposits.

The original forest growth consisted of maple, beech, elm, ash, and hemlock, with white cedar, spruce, and tamarack in the swampy depressions. The larger portion of this phase has been cut over, though large tracts of virgin forest still remain. The most extensive forest now remaining occupies the southern half of Antioch Township. By far the greatest proportion of soil under cultivation in the county is of this phase, though large areas are still in the "slashing" stage. This land is being quite rapidly cleared, and each year new farms are opened up and put under cultivation.

The field crops grown at present are potatoes, corn, oats, wheat, rye, buckwheat, beans, pease, and clover, with cabbage, tomatoes, root

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crops, and strawberries as garden crops. Potatoes are the money crop, the soil being well adapted to their growth. Yields range from 100 to 300 bushels per acre, with an average of about 150 bushels. Corn, while grown to considerable extent, is not as successful as in the southern part of the State. Both dent and flint varieties are grown. Late spring and early fall frosts sometimes damage the crop, and special attention should be given to developing varieties better suited to the short season. The yields range from 20 to 45 bushels per acre. The soil is light for oats and wheat, but both are grown, the former yielding from 25 to 40 bushels and the latter from 12 to 22 bushels per acre. Rye and buckwheat do very well, as do also beans and pease. Clover is a valuable crop, producing from 1 to 1½ tons of hay per acre. It also gives good yields of seed and should be grown for this purpose, as the crop finds ready sale at good prices. Alfalfa, while not grown to any extent at present, will yield fairly well if given proper care. In Selma Township some alfalfa was seen which had gone to seed. The plants were thrifty and the seed well developed. It is very seldom that alfalfa will seed in Michigan, but if attention were given the matter of selection a strain could doubtless be developed which would regularly mature seed. The hardy varieties of apples, pears, plums, and grapes do well and the fruit industry could be profitably extended on this phase of the Miami sand.

Commerical fertilizers are not used to any great extent at present, but a small amount of stable manure is applied. Clover, rye, and buckwheat are sometimes plowed under, a practice which should be more generally followed in order to build up and maintain the productiveness of the fields.

Farms on this soil, partially improved, bring from $10 to $40 an acre, depending on location and improvements. Stump land can be bought as low as $7.50 an acre. Timbered land is owned principally in large tracts by the large lumber companies and is not for sale.

Pine plains phase.—The Miami sand (Pine plains phase) to a depth of 2 to 4 inches consists of a brown or grayish medium sand, carrying only a very small proportion of organic matter, underlain to 36 inches, and usually much deeper, by a yellowish-brown or yellow sand of medium texture, which becomes lighter in color with increased depth. There is present on the surface and mixed with both soil and subsoil a small amount of glacial gravel. At intervals throughout this soil, as in the Hardwood land phase, clay sometimes outcrops or comes very near the surface. It is probable that the greater part of the phase is underlain by clay, though the depth of its occurrence is irregular and it often lies so far from the surface as to have little or no influence on the crops. In the borings a thin layer of clay from 1 to 3 or 4 inches in thickness is sometimes encountered, and in deep road cuts these layers are also seen. On account of the loose,

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open character of this soil it is very easily cultivated and the natural drainage is good.

The largest area of the Pine plains phase occurs along the Manistee River in the north and northeast portions of the county. Another extensive area is found to the north and northeast of Lake Mitchell. Smaller areas are found in the southwestern part of the survey.

The topography is level or undulating. The area north of Cadillac has somewhat the appearance of an ancient valley. Clam River, the outlet of Lake Mitchell and Lake Cadillac, passes through this valley before entering the Muskegon River in Clare County.

The original forest growth consisted of Norway and white pine, all of which has been removed. In the extreme northeastern and southwestern parts of the county some jack pine was found. In texture the soil very much resembles the phase first described, but the organic matter content is smaller and the timber growth is entirely different. The present vegetation consists of poplar, birch, huckleberries, and sweet fern.

Though all the merchantable timber has been removed, only a very small percentage of this phase is under cultivation. All that is necessary to fit the land for cultivation is the removal of the pine stumps. This is a matter of some difficulty and expense, the cost of clearing ranging from $10 to $20 an acre. This difficulty, however, is now being overcome to an extent.

There has recently been erected in Cadillac a plant for the manufacture of turpentine from the Norway pine stumps, and this will enable the farmers to have their land cleared of stumps without expense to them. The company will pull the stumps and pay $2 a cord of 4,000 pounds for them, or they will pay $4 a cord for stumps delivered in Cadillac. They also hope to utilize the white pine stumps in making pulp. It is estimated that from 20 to 40 per cent of the pine in the county is Norway.

The crops grown on the Pine plains phase are potatoes, oats, corn, rye, buckwheat, beans, pease, and clover. Potatoes are grown more extensively than any other crop, and, considering the light character of the soil and the methods followed, the yields are good, ranging from 75 to 150 bushels per acre. The yield could be materially increased by plowing under green crops such as clover, rye, or buckwheat, thus increasing the organic matter content and the water-holding capacity of the soil. The yields of corn, oats, beans, and pease are lower than on the Hardwood land phase. Hardy varieties of apples, pears, and grapes do fairly well, though not grown to any extent. The area of clover should be extended and clover seed made one of the money crops of the farming system.

This phase responds quickly to fertilization and thorough cultivation. It retains moisture remarkably well for a light soil. The

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land ranges in value from $5 to $20 an acre, depending upon location and improvements.

Pine hills phase.—The Pine hills phase of the Miami sand to a depth of from 2 to 4 inches consists of a gray or brownish medium sand, containing very little organic matter. The subsoil, to a depth of 36 inches and usually much deeper, consists of a yellow medium sand, which becomes lighter in color with increasing depth. There is present on the surface and mixed with the soil and subsoil from 5 to 15 per cent of gravel.

The topography is rolling to hilly and broken. On account of this and the loose, open character of the soil the natural drainage is very free and the soil is droughty. As far as types of native vegetation and soil texture and structure are concerned, this soil is identical with the Pine plains phase. The difference in topography and agricultural value, however, is so marked that it was considered advisable to show the soil as a distinct phase. It contains a little more gravel than the Pine plains phase, but this in itself would not justify a separation.

The most of the Pine hills phase occupies the southern part of Cedar Creek, the northern and eastern parts of Haring, and the northeastern part of Clam Lake townships. Another area of considerable extent is found in the southern part of Cherry Grove Township.

The original timber growth consisted of Norway and white pine, all of which has been removed. The tree growth at present consists of poplar and birch, with an undergrowth of shrubs, such as huckleberries and sweet fern.

Only a few scattered fields are cultivated, and it is unlikely that much of the phase will ever be utilized for agriculture. It is really a nonagricultural soil and should be reforested. Land of this character can be bought from $2 to $10 an acre.

The following table gives the average results of mechanical analyses of fine-earth samples of the three phases of Miami sand:

Mechanical analyses of Miami sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
Hardwood land phase:		*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*
19086, 19633, 19635	Soil	1.0	15.9	28.9	39.6	3.1	8.3	2.9
19087, 19634, 19636	Subsoil	.5	18.5	27.2	44.8	3.2	3.4	2.5
Pine plains phase:								
19084, 19631	Soil	.3	16.9	32.2	39.3	2.1	6.1	2.9
19085, 19632	Subsoil	.2	14.6	35.1	43.1	2.3	2.4	2.3
Pine hills phase:								
19639	Soil	.0	10.1	45.1	36.1	1.4	5.0	2.2
19640	Subsoil	.0	11.1	49.4	34.7	.9	1.6	2.2

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DUNKIRK CLAY LOAM.

The soil of the Dunkirk clay loam consists of 4 to 6 inches of light-brown heavy loam, silt loam, or light clay loam. The subsoil to a depth of 36 inches is a brownish-red clay loam or clay. The variation in the soil texture is due to the fact that the type occurs only in small areas and the material is more or less mixed with the surrounding lighter soils. Although this is the heaviest soil in the area and the most difficult to cultivate, no trouble is experienced in securing a good seed bed if plowed under favorable moisture conditions.

There are only a few square miles of the Dunkirk clay loam in the county. One small area occurs about 1 mile south of Lake Cadillac and another of about equal size is found in the southeastern corner of Greenwood Township. Other smaller areas occur throughout the county, many being too small to be represented upon the soil map.

The Dunkirk clay loam is of glacial origin, and the greater proportion of the county is probably underlain at varying depths by material similar to that giving rise to this type of soil.

The surface is level or gently rolling. The natural drainage is fairly good, though in some places it could be materially improved by tile drains.

The same crops are grown on this soil as on the Miami sand (Hardwood land phase), but the yields are usually somewhat better. It is a strong, productive soil. Plowing should be deeper than on the light soils, and more thorough subsequent cultivation is necessary. It is better adapted to the production of hay and grain than to potatoes.

CLYDE CLAY LOAM.

The Clyde clay loam consists of a light-textured black clay loam to a depth of 6 or 8 inches, underlain by a bluish or drab-colored, heavy plastic clay loam extending to a depth of 36 inches. The soil is variable, being more or less mixed with material from the adjoining lighter types of soil.

The area of this soil is very limited—less than 1 square mile in all. This occurs in two small areas in the eastern part of Greenwood Township. It was formerly swamp land, but having been reclaimed it is now used for the production of hay. Yields of from 1 to 2 tons per acre are obtained. The natural drainage is poor, but open ditches have been constructed to carry off the surplus water.

As the soil is variable and of such small extent no samples were collected for analyses.

MUCK.

Muck consists of vegetable mold in various stages of decomposition. The greater portion is of black color and thoroughly decom-

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posed; the remainder is brown, and would be more properly classed as peat if of sufficient extent. There are no extensive areas of Muck, but it is found along parts of nearly all the smaller streams and to a slight extent along the Manistee River.

The original growth consisted of white cedar, spruce, and tamarack, with some ash.

The Muck is shallow in small areas, often not exceeding 1 foot, while in the larger areas it extends to a depth of from 3 to 10 feet. Except in a few places, where the substratum is clay, it is underlain by sand.

None of this soil is cleared and under cultivation. At present it is poorly drained and in a swampy condition. Most of it is capable of being reclaimed, and when cleared and put under cultivation will be a valuable soil, especially for gardening.

SUMMARY.

Wexford County lies in the northwestern portion of the southern peninsula of Michigan. It has an area of 366,272 acres, or about 572 square miles. The topography varies from level to hilly and broken, the greater part, however, being level to gently rolling. Except in the southeastern corner, which drains through Clam River into the Muskegon River, the drainage of the county is into the Manistee River.

The first settlement was made in the area in 1863, and in 1869 the county was organized. Cadillac, the county seat, was incorporated in 1877 and is the most important point in the county. Aside from its importance as a lumber town, it is fast coming to the front as a distributing center for agricultural supplies and as a shipping point for all farm products. Its population at present is 9,000.

The Grand Rapids and Indiana, the Ann Arbor, and the Manistee and Northeastern railroads traverse the county.

The winters are long and cold, but the temperature is uniform. The climate in summer is delightful and vegetation grows rapidly. The average annual rainfall of 32.4 inches is fairly well distributed throughout the year.

Originally the county was covered with forest. The pine has been removed and also the greater part of the hardwood. About 15 to 20 per cent of the area is under cultivation, and by far the greater proportion of this is in the Hardwood land phase of the Miami sand.

Lumbering is still an important industry. The output of the mills within the county amounts to over 100,000,000 feet annually. The cut-over lands are being settled and agriculture is coming to the front.

The products of the farm are potatoes, corn, oats, wheat, rye, buckwheat, hay, beans, pease, garden truck, and fruit. Potatoes form the

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money crop. The soil is well adapted to potatoes and yields range from 75 to 300 bushels per acre. Oats and wheat do fairly well, but wheat should be confined to a heavier soil. Although corn matures here, both flint and dent varieties being grown, a strain better adapted to the soil and climatic conditions should be developed. Rye and buckwheat do well, also pease and beans. The hardy varieties of apples, pears, and grapes do well, though not grown extensively. The dairy industry while unimportant is growing. The dairy products are all consumed in the local markets.

No definite crop rotation is followed, but it is customary to grow potatoes on new ground for one or two years, usually followed by corn, after which the field may be seeded. Potatoes usually follow the sod. Rye and buckwheat and clover are sometimes grown as green manure crops. No commercial fertilizers are used, but some barnyard manure is applied.

Labor for the farm can be readily secured for $20 to $25 a month, with board. About 91 per cent of the farms are operated by the owner. The average size of a farm is about 80 acres.

Four soil types, including Muck, were mapped. Miami sand, which is shown in three phases, is the most extensive type, covering 97.5 per cent of the county, the most important phase being locally known as hardwood land. Although a light soil, it yields well and its productiveness can be maintained by proper cultivation and fertilization. The average value of farms on this phase of the Miami sand is from $15 to $20 an acre.

The Miami sand (Pine plains phase) is also a light soil, but it has agricultural possibilities which are just beginning to be developed. The soil contains but little organic matter, but as it responds quickly to intelligent treatment it can be built up and profitable yields secured.

The Miami sand (Pine hills phase) is a nonagricultural soil and the entire area should be reforested. It represents the broken and billy land, and only a few fields have been cleared.

The Dunkirk clay loam is the heaviest type in the area. It is adapted to general farming, but owing to its small extent it is unimportant.

Less than 1 square mile of the Clyde clay loam was mapped. It is devoted to the production of hay, which does very well.

The areas of Muck are uncleared and still remain in a swampy condition. They will form a valuable soil when brought under cultivation.

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SOIL SURVEY OF ALLEN COUNTY, INDIANA.

By GROVE B. JONES and CORNELIUS VAN DUYNE.

DESCRIPTION OF THE AREA.

Allen County is located in the northeastern part of Indiana, and is bounded on the north by Dekalb and Noble counties; on the east by the State of Ohio; on the south by Wells and Adams counties; and on the west by Whitney and Huntington counties. The county is included within meridians 84° 50′ and 85° 20′ 25″ west from Greenwich and parallels 40° 50′ 30″ and 40° 18′ north latitude. It is the largest county in the State, and embraces an area of 667 square miles, or 426,880 acres.

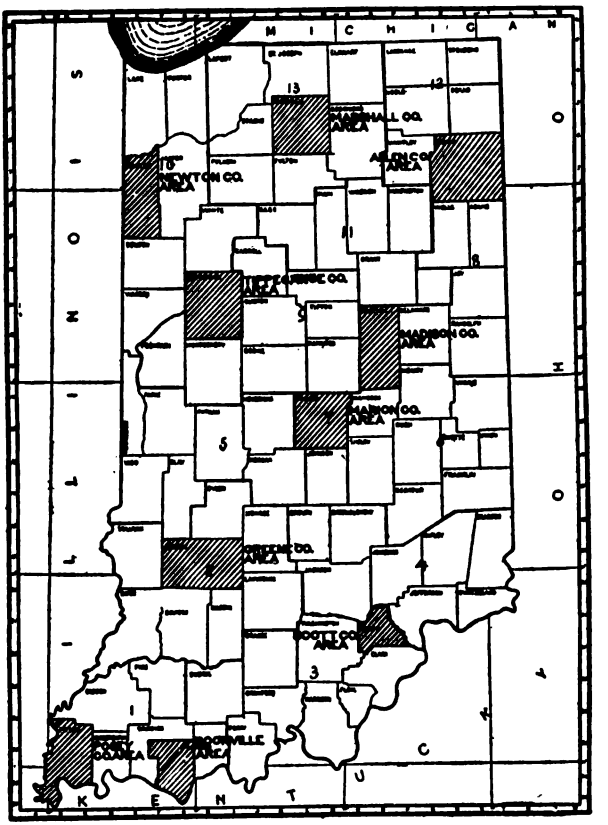

FIG. 30.—Sketch map showing location of the Allen County area, Indiana.

The surface features of the county are those characteristic of a glaciated region, varying from low, level, or depressed areas—the sites of ancient lakes—to rolling and hilly, the latter being the usual surface features of moraines. The morainic belt extends in a northeasterly-southwesterly direction across the county. It passes through Fort Wayne, where it is intersected by the St. Joseph and St. Marys rivers, which at this point unite to form the Maumee River. From Fort Wayne a lobe of this moraine extends southeast to the county

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line. The extreme northwest corner of the county is also crossed by another morainic strip.

These morainic belts present a varied topography and give to the county is most rugged scenery. Though their general elevation is much above the surrounding country and their surface for the most part is rolling to hilly, there occur many small, level to gently undulating areas. Between the morainic hills and ridges numerous swamps, saucerlike depressions, and small lakes form a salient feature of the landscape everywhere. In the northern part of the county the hills and kamelike eminences occur particularly well developed, especially in Perry and Cedar Creek townships. The highest point in the county is located upon "Dutch Ridge," in Perry Township. This ridge is a broken, gullied strip of country, with an average height of about 50 feet above the surrounding lowlands. The sides of the ridge are badly dissected and eroded by deeply cut, steep-sided, irregular valleys, varying in width from one-eighth to one-fourth mile. Some of the valleys in the morainic country have the appearance of having carried much larger volumes of water in former times and of having later become partially filled with glacial débris. These valleys vary in width from one-eighth to one-fourth mile.

Generally speaking, the southern half of the county consists of intermorainic stretches having a gently undulating to fairly level topography. The exceptions are found in the southwest corner and along the east side of the St. Marys River, where the moraines give rise to gently rolling to hilly country.

The Maumee Lake Bottom, which embraces over 100 square miles of country in the eastern part of the county, is the largest level area. The surface features are level to gently undulating, with an occasional knoll or ridge. This tract was known as the Black Swamp, but has been reclaimed by artificial drainage.

Another level semiswampy area is found extending southwest from Fort Wayne to the western boundary of the county. This formation represents an abandoned channel which at one time conveyed the waters of Lake Maumee into the Wabash River. It is locally known as Little River Prairie.

The St. Joseph and St. Marys rivers rise in Ohio and flow through the eastern portion of Allen County to Fort Wayne. The St. Joseph flows in a general southwesterly direction, the St. Marys in a northwesterly direction, until they unite at Fort Wayne, forming the Maumee River. The eastern and central parts of the county are therefore drained by these three rivers and their tributaries.

The western part of the county is drained by Eel River, Aboite Creek, Little Prairie Creek, and the tributaries of these streams. This drainage is in a southwest direction to the Wabash River. The

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county thus forms a watershed, part of whose waters discharge through the Maumee, the Great Lakes, and the St. Lawrence into the Atlantic, and the rest through the Wabash, Ohio, and Mississippi into the Gulf of Mexico.

Fort Wayne, the only city of the county, has an estimated population of 61,195. It is situated nearly in the geographical center of the county and is sometimes called the "Summit City," because it is at about this point that the east and west railway lines cross the divide between the waters which flow into the Mississippi and those which flow into Lake Erie. Fort Wayne is the county seat and is a progressive and prosperous city. It covers an area of 9 square miles and has a number of manufacturing plants.

There are a number of small towns and villages in the county. In the northern half are Dunfee, Arcola, Huntertown, Ari, Leo, Cedarville, Grabill, Maysville, Harlan, and Woodburn, named in order from west to east. In the southern half and named in the same direction are Zanesville, on the southern margin, Ninemile, Yoder, Poe, New Haven, Hoagland, Maples, Monroeville, Townley, Baldwin, Dixon, and Edgerton.

General Anthony Wayne, on September 18, 1794, selected the present site of the city of Fort Wayne, at the junction of the St. Marys and St. Joseph rivers. This early white settlement was known as Fort Deposit, and furnished protection to the pioneers. Much interesting history is linked about this spot. It was called by the Indians Ke-ki-on-ga, meaning "Central City."

Under the treaty of St. Marys, 1818, lands ceded by the Indians came into possesison of the United States. In 1822 Fort Wayne was laid out, and in 1823 the county of Allen was organized out of Randolph and Delaware counties.

The first settlers came in by way of the St. Marys River, from Ohio, New York, and other eastern States. They selected the timber lands along the St. Joseph and St. Marys rivers for their first settlements. The tide of immigration, however, did not begin until the decade of 1840–1850.

The county roads as a rule are in good condition. The principal roads leading into Fort Wayne are macadamized or graveled, and in the eastern and southeastern parts of the county there are many miles of permanent macadam roads. Much of the material used for road construction is a durable blue limestone, but upon about half of the roads of the county the gravel deposits, which are so common in the morainic sections, have been utilized. This material is often too fine for good results, and in all cases is less durable than the limestone. Where the Clyde clay and other heavy soils are crossed by roads not graveled they become, in wet seasons, almost impassable from deep, stiff mud.

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Allen County is well supplied with railway lines. With the exception of the extreme northeastern township, Scipio, every township is traversed by one or two lines of railway, and shipping points are easily reached from all parts. The following railroads enter Fort Wayne: The Pennsylvania (main line), the Grand Rapids and Indiana, the Wabash (two lines), the Lake Erie and Western, the Lake Shore and Michigan Southern, the New York, Chicago and St. Louis, and the Cincinnati, Hamilton and Dayton. The Vandalia Railroad crosses the northwest corner of the county and furnishes an outlet for that section. In addition to the steam roads the following electric lines center at Fort Wayne: The Fort Wayne and Wabash Valley Traction Company's lines run southwest from the city along the northern edge of the "prairie" to Huntington, Indianapolis, and Lafayette. Another line runs south to Bluffton. The Ohio Electric Railway Company's lines pass east through New Haven and Monroeville to Van Wert and Lima, Ohio. The Fort Wayne and Springfield Railway runs southeast to Decatur, and the Toledo and Chicago Interurban Railway runs north through Huntertown to Waterloo. A proposed electric line running northwest from Fort Wayne will, when completed, connect it with South Bend, Ind.

Fort Wayne is the market for all of the products of the county, and considerable produce is shipped in from outside districts.

CLIMATE.

The climate of Allen County is healthful and well suited to carrying on general farming. No official weather records are available for the county; those which appear in the accompanying table were taken from the records of the Weather Bureau station at Angola, two counties to the northward. It is believed, however, that the data given represent approximately the conditions which prevail over Allen County.

The winters are rather long and cold, and are usually accompanied by considerable snow. The mean temperature for December, January, and February, covering a period of eighteen years, is about 26° F., while that for the three following months for the same period is about 48° F. The mean temperature for the months of June, July, and August, covering a period of eighteen years, is about 72° F., while that for the three following months for the same period is about 51° F. The mean annual temperature is about 49° F. The temperature seldom reaches 100°, and zero weather seldom lasts for more than one or two days at a time.

The mean annual precipitation for a period of eighteen years is about 39 inches. The mean snowfall for December, January, and February covering this same period is about 29 inches. During

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these same months, however, a considerable precipitation—about 2½ inches monthly—occurs in the form of rain. For March, April, and May the mean rainfall is about 10 inches, while the snowfall is also about 10 inches. During the summer months of June, July, and August the average rainfall is about 3½ inches per month, while that for the following three months is about the same. In general, the rainfall is quite evenly distributed throughout the growing season. Crops seldom suffer from extreme drought or from excessive moisture.

The length of the growing season is about five and one-half months, the average dates of the last killing frost in the spring and the first in the fall for a period of fifteen years being April 27 and October 14, respectively. During this same period the very latest date of a killing frost in the spring was May 21, and the earliest in the fall was September 21. The climatic conditions of the county are representative of those over a large portion of the northeastern United States.

Normal monthly, seasonal, and annual temperature and precipitation at Angola.

Month.	Temperature.			Precipitation.			
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year.	Total amount for the wettest year.	Snow, average depth.
	°F.	°F.	°F.	Inches.	Inches.	Inches.	Inches.
December	29	65	—18	2.6	2.0	1.5	8.7
January	24	64	—20	2.4	1.8	2.4	10.8
February	24	62	—25	2.8	2.2	2.0	9.7
Winter	26	.....	.....	7.8	6.0	5.9	29.2
March	34	76	—10	3.0	2.7	3.1	7.8
April	48	90	15	2.8	2.1	5.9	2.7
May	61	100	26	4.0	6.6	4.4	0.2
Spring	48	.....	.....	9.8	10.4	13.4	10.7
June	70	104	38	3.9	1.8	3.6	0.0
July	74	104	45	4.0	1.1	12.8	0.0
August	71	101	44	3.2	0.9	7.6	0.0
Summer	72	.....	.....	11.1	3.8	24.0	0.0
September	64	100	28	3.5	5.2	5.9	0.0
October	51	90	18	2.9	3.0	0.8	0.1
November	38	76	7	3.6	2.7	2.1	5.1
Fall	51	.....	.....	10.0	10.9	8.8	5.2
Year	49	104	—25	38.7	31.1	52.1	45.1

AGRICULTURE.

The development of agriculture in the early days was necessarily slow, for the country was heavily forested with oak, hickory, elm, maple, beech, and other hardwoods. Corn was the chief crop planted in the partially broken new ground. This crop was usually followed

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by wheat, while another area was cleared for corn the following year. On account of the absence of ready markets the most of the grain produced was consumed at home. Occasionally ox teams hauled small loads of grain to Chicago or Cincinnati and returned with other provisions. On account of the distance and the poor condition of the roads such trips usually required several weeks.

Upon the completion of the Erie-Wabash Canal in 1843, which furnished direct communication with the Ohio River, the development of agriculture became more rapid. Large areas were cleared, better farming implements were used, and higher prices were paid for the products.

After immigration became active in the forties and fifties, the development was steady. About twenty years after the completion of the canal—that is, in 1863—the Wabash Railroad was constructed and other lines soon followed, forcing the abandonment of the canal in 1881. About this time large areas of swamp land lying south of the canal were cleared, drained, and put in cultivation, and to-day only a small percentage remains unreclaimed. These drained swamp lands are the strongest corn soils in the county, command the highest price, and are an important factor in the county's wealth.

The general character of agriculture has not greatly changed since the beginning. Corn and wheat constituted the first crops, but the yield of wheat has gradually decreased because of continuous cropping, and more attention has been given to oats and hay. During the last twenty years the acreage devoted to corn and oats has greatly increased, owing to the draining of the swamp lands. According to the census of 1900 the number of acres in corn was 70,840, in oats 50,715, and in wheat 3,765. This year, 1908, it is believed the wheat acreage is not over 2,000 acres, though this small showing is due partially to the very dry fall, which prevented seeding. The average yield per acre of hay for the county is about 1½ tons. The first crop of clover is cut for hay and the second generally harvested for the seed. By this method little or no humus is added to the soil and the grass lands of the county are generally deficient in organic matter. Alfalfa can be successfully grown on the upland soils and should be more extensively planted. It will prove a valuable feed, a splendid soil renovator, and of importance in the system of rotation. Buckwheat, rye, rape, and sugar beets are grown to a limited extent. The sugar beets are produced upon the Clyde clay in the eastern part of the county, the yields ranging from fair to good. The beets are shipped to Fremont, Ohio, where is located the nearest sugar factory.

The soil and climatic conditions are well suited to sugar beets, and there would seem to be no reason why the acreage of this crop should not be greatly increased. Many of the beets now produced are grown under contract, the price paid being $5 a ton. The cost of seed per

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acre is $2.50, for the hire of the company's tools 55 cents, and weeding and thinning $18 per acre. The yield this year ranged from 8 to 10 tons per acre. Comparatively little commercial fertilizer is used.

Stock raising has never been of great importance and at present is confined chiefly to the production of pork. Dairying has never been extensively carried on and provides only for the local demand.

With the growth of Fort Wayne into a large manufacturing city and the resulting increase in demands for fruit and vegetables, more attention has been given to these special crops. The city furnishes a splendid market for such products, all of which do well on the sandy soils just east and west of town. Apple and peach orchards planted upon the Dunkirk sandy loam and given proper care will doubtless prove remunerative. Potatoes grow well upon the lighter soils and upon the lighter phases of the Muck and Peat areas. The supply of vegetables and fruit is even yet inadequate, and many carloads are shipped in annually.

The importance of crop rotation is recognized and quite generally practiced upon the Miami clay loam. The common practice consists of plowing sod land for corn, following this with oats, and then with wheat. If wheat is included in the rotation, timothy is usually sowed in the fall and clover in the spring; otherwise both are sowed in the spring with the oats. The land is allowed to remain in grass for two or three years, the period depending usually on the ability of the clover to withstand the heaving of the soil and on the relative prices of hay and corn. On the Miami black clay loam wheat is usually omitted from the rotation and corn is planted for two or more years. The Clyde clay in planted to corn for several successive seasons, followed by oats, seeded, and allowed to remain in clover only one year.

The matter of drainage is an important problem for the farmer of Allen County, and especially is this true in the eastern and northwestern parts of the county. Most of the farms of the upland are equipped with effective systems of tile drains. In the large level tracts of land the main open ditches become partially filled with sediment and plant growth and require frequent cleaning. Ditching machines for constructing the small lateral ditches are in common use. Tile is manufactured in several places in the county and can be secured at reasonable prices.

Eel River ditch, completed in 1887, is 11 miles long and drains over 3,000 acres of land. Little River ditch, completed in 1889, with all its branches, is 40 miles in length and furnishes an outlet for the water which falls upon 200,000 acres.

In 1900 the value of farm lands and improvements of Allen County, exclusive of buildings, was $14,565,350, and the value of farm buildings amounted to $4,707,320. The farms contain a total area of 397,235 acres and have an average extent of 90 acres. The

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value of farm land ranges from $50 to $150 an acre. The corn and truck soils command the highest price. Drained Muck sells for about $80 an acre, and much of this soil could be improved by more complete drainage systems.

About 60 per cent of the farms are operated by the owners. Where tenanted, share rent is the common plan, although a money rental is coming into more general use. The usual rent on the share basis is two-fifths of the products, the renter furnishing everything. When the owner furnishes the seed, etc., he gets one-half of the products. Money rents range from $2 to $5 an acre, depending upon the kind and condition of the soil and the character of the improvements. Day laborers receive $2 to $2.50, and those hired by the month from $15 to $30, with board.

The agriculture of Allen County is of a progressive and advanced type. Farm machinery of the latest designs—corn planters, shredders, harvesters, wheat drills and harvesters, manure spreaders, ditching machines, in fact everything needed to handle the soil and the crops in the most economical way—is found upon the farms. The soils being strong and fertile, but little resort is had to commercial fertilizers. On the other hand, the great value of barnyard manure is thoroughly appreciated, and large quantities are used, mainly on the corn and wheat.

SOILS.

Indiana lies within the region which during comparatively recent geological time was subjected to glaciation, the ice having invaded the country a number of times. This great snow-covered ice sheet, 1,000 feet or more in thickness, covered the country as far south as the Ohio River and in some places beyond that river, just as Greenland is covered to-day. During its slow advance southward great quantities of earth and rock which were carried on the ice, pushed along beneath it, crushed and mingled, were upon the melting of the ice sheet left as a thick mantle over the surface of the country, in many cases entirely obliterating the then existing surface features. Geologists believe that there were four or five successive invasions of the ice over this section, each adding to the vast deposits found to-day—an earthy mass of heterogeneous material covering the northern three-fourths of the State, in some places to a depth of 500 feet. In Allen County the depth of the deposits ranges from 40 to 280 feet.

As far as Allen County is concerned, the most important period of glaciation was the Wisconsin stage, a period marked by heavier deposits of drift than those of any other ice invasion.

Ridges of drift material, known as terminal moraines, form important topographic features of the county. These moraines are varied in constitution and in the arrangement of the different grades

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of material, like clay, sand, and gravel, and give rise to several soil series. One of the most important of these ridges is the St. Marys Ridge, named from the St. Marys River. The course of the river in the eastern part of Allen County is determined for a distance of about 20 miles by this ridge, and in like manner the course of the St. Joseph River is controlled for nearly the same distance.

Another moraine of less importance is known as the Van Wert Ridge, which crosses the Maumee River about half way between Fort Wayne and New Haven. Other smaller moraines are found in different parts of the county.

Another topographic feature of the county, important both in area covered and its influence on the soil formation, is the extensive depression now known as the Maumee Valley, which during Glacial times was a great inland lake receiving the waters of the St. Marys and St. Joseph rivers. The outlet of this lake was to the westward through the Little River and Wabash Valley to the Gulf. Large amounts of reworked glacial débris were carried into this inland lake and spread out over its bottoms as sediments. Later, when the level of Lake Erie was lowered, the waters of this inland body broke through one of the lower moraines hemming it in on the north and thus established the present drainage toward Lake Erie.

Evidently the former river flowing westward from Maumee Lake was a very large one, as is indicated by the large river valley which it occupied. This valley extends from a point east of the city of Fort Wayne to the southwest, joining the present Wabash River Valley near Huntington. The old channel or valley is known as the Erie-Wabash gap and the materials found there give rise to a number of soil types.

In connection with the description of Maumee Lake another interesting feature should be mentioned. This is the abandoned channel which crosses Adams Township, from the St. Marys River to a point 2 miles southwest of New Haven. This channel was probably used during interglacial times by the St. Marys River, which evidently made a cut-off and emptied into the interglacial Maumee Lake at a point just south of where New Haven now stands. The banks are well defined, rising in height from 15 to 25 feet above the intervening lowlands, and the old stream bed is occupied by the Clyde clay, which is the predominating soil of the glacial lake bed itself.

Further evidence of the interglacial position of the St. Marys River is seen in the delta formed at its supposed mouth. This delta, known as the New Haven delta, has a length east and west of 4 miles and a width north and south of about 1 mile. It is composed largely of sandy types of soil, several small sand knolls occurring in its eastern extremity.

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No rock outcrops occur within the county, but from deep well borings the underlying formations have been determined. As these in no way influence the soils they may be dismissed with the merest comment. In the boring of the artesian well in the court-house square at Fort Wayne the drift was found to extend to a depth of 88 feet, where it rested on limestone. The limestone in the southern half of the county is the Niagara of the Upper Silurian and in the northern half Corniferous of the Devonian. South of Maysville, near the northern border of Maumee Lake basin, flowing water is found 35 to 45 feet below the surface. These wells are fed by reservoirs in the gravel beds of the moraine to the north.

All the soils of Allen County are of glacial origin. The upland soils are derived directly from the glacial deposits, while the glacial lake and swamp types are derived from the drift merely reworked by streams and laid down in more or less quiet waters. Such material and processes of formation give the Clyde series of soils. The alluvial lands are similarly derived. They belong to the Wabash series.

In all fourteen soil types, representing five soil series, were mapped. Two types are members of the Miami and three of the Dunkirk series, the Clyde has three representatives, the Wabash series two, and the Waverly series one. Muck, Peat, and Meadow, of the organic and miscellaneous soil groups, were also mapped.

The name and the actual and relative extent of each soil are shown in the following table:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Miami clay loam	244,480	57.3	Dunkirk fine sandy loam	4,096	1.0
Clyde clay	65,920	15.4	Dunkirk fine sand	2,944	.7
Miami black clay loam	51,840	12.1	Waverly silt loam	2,240	.5
Clyde loam	12,800	3.0	Wabash fine sand	1,536	.4
Muck	11,392	2.7	Clyde fine sandy loam	1,408	.3
Wabash silt loam	11,136	2.6	Peat	640	.1
Dunkirk sandy loam	10,240	2.4	Total	426,880	.....
Meadow	6,208	1.5			

MIAMI CLAY LOAM.

The soil of the Miami clay loam consists of a light-brown or gray silty loam from 8 to 12 inches deep, beneath which to a depth of about 24 inches is a heavy yellowish-brown silty clay. The silt content of the subsoil decreases with depth and at an average of 2 feet gives way to a stiff, impervious brown clay. Frequently in the rolling areas of the type a layer of silt 1 to 3 inches in thickness is found immediately beneath the surface soil.

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Glacial bowlders and rock fragments, consisting of granite, quartz, syenite, greenstone, and siliceous slate are sometimes present on the surface and disseminated through both soil and subsoil, but these are seldom numerous enough to interfere with cultivation. A few small gravel pits occur in steep banks adjacent to stream courses at a depth of 15 to 25 feet below the surface.

Where the Miami clay loam occurs bordering large depressions and also as knolls and ridges within such depressions, there is nearly always present in the soil varying amounts of fine sand in excess of the typical soil. This is particularly true in Lake Township.

Land of this type of soil is found in every township and covers a greater proportion of the county than all the other types of soil. The largest and most typical areas occur in the northern and western parts of the county. Slight local variations due to the varying drainage conditions occur throughout the type, but generally it possesses marked uniformity in texture. The surface features range from gently rolling to hilly, and in the northern part of the county it occupies some of the most broken and roughest areas. When the Miami clay loam is found in fairly level hummocky country the small knolls possess the texture and color of the Miami clay loam, while the intervening spaces are the Miami black clay loam. It should be borne in mind, therefore, that the boundary lines as indicated on the map between these two soils do not always denote an abrupt change from the one soil to the other, and some few areas were found in which the Miami clay loam and Miami black clay loam were so mingled that they could not be shown as separate and distinct soils upon a scale of 1 inch to 1 mile. In such cases the map shows the predominating soil. These hummocky areas support an uneven crop growth, owing principally to the difference in the productiveness of the Miami clay loam on the hummocks and the Miami black clay loam in the depressions.

The Miami clay loam is the best drained of any of the heavy soils, but it is somewhat more deficient in organic matter than the Miami black clay loam, because it has never passed through the swampy conditions of the latter type. Upon the rougher areas, where the drainage is sometimes excessive, considerable washing and gullying has taken place on the slopes. The soil in these eroded areas is more deficient in organic matter than elsewhere and has an ashy appearance. Usually artificial drainage is not necessary, but there are some rather low, flat interstream areas and draws which have been greatly improved by tiling. The type is of glacial origin and is derived from the weathering of the mantle of glacial till. The original tree growth consisted of oak, ash, hickory, elm, sugar maple, and a few sycamore and beech, and many fair-sized wooded areas still remain.

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The Miami clay loam is the general-purpose soil of the county, and upon it all the varieties of farm crops are produced. If handled at the proper time it is not a difficult soil to cultivate. If plowed when either too wet or too dry it has a tendency to clod. By disking before plowing it is claimed a more desirable seed bed may be secured. Wheat, oats, corn, and hay are the principal crops. The yield per acre of wheat ranges from 18 to 30 bushels; of oats, 30 to 50 bushels; of corn, from 25 to 50 bushels; and of hay from 1½ to 2½ tons. For wheat the Miami clay loam is considered one of the best soils in the county, but for corn it is excelled by other soils and the yields are below those secured from the darker colored types.

A common rotation on this type is to turn under the sod and keep the field in corn for two years; the following year a liberal application of barnyard manure is given and the field sown to oats; wheat follows in the fall, and at the same time the land is seeded to timothy and in the spring to clover. In growing wheat some farmers advise plowing clover or corn-stubble land in June, and if there has been abundant rainfall a later plowing or disking before sowing. Green manuring is a very valuable means of restoring organic matter to the soil and should be practiced more generally. The Miami clay loam sells for $50 to $100 an acre.

The following table gives the average results of the mechanical analyses of fine-earth samples of this soil:

Mechanical analyses of Miami clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19975, 19977	Soil	0.5	3.0	2.9	6.1	5.6	54.9	26.8
19976, 19978	Subsoil	.0	1.5	1.6	4.9	5.9	50.1	35.7

MIAMI BLACK CLAY LOAM.

The surface soil of the Miami black clay loam is a heavy dark-brown or black loam or clay loam with an average depth of 12 inches. Near the margin of the areas the depth of the soil is usually considerably less than this. The prevailing dark color is due to accumulations of organic matter, and in the lower depths of the soil, where the organic content naturally decreases, the color gradually becomes lighter. The soil gradually becomes heavier with depth and at about 14 inches below the surface grades into the subsoil, a light-brown or mottled yellow and brown clay or heavy clay loam, which at a depth of about 24 inches changes into a yellow or light-brown, heavy, impervious clay continuing to a depth of 3 feet and

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more. When wet the soil is sticky and gummy and if worked in this condition it bakes and clods badly, but when dry it is usually friable and loamy and can be handled with comparative ease.

Large areas of this type of soil occur in the southern tier of townships and in the region north and west of Arcola. Other small isolated areas, many too small to be shown upon the map, occur in all parts of the county outside of the Maumee Lake Basin and the Erie-Wabash channel.

The Miami black clay loam occupies shallow, saucerlike basins and depressions in the uplands and narrow strips along some of the smaller streams. The upland areas are often large and irregular and are sometimes connected with each other by a narrow strip of the same soil. Owing both to the level, depressed surface of the type and the impervious nature of the subsoil the drainage is naturally poor. The greater part is drained by open ditches and tile drains, and is under cultivation. The undrained and uncultivated areas support a heavy growth of oak, hickory, and elm.

This type of soil owes its origin to an accumulation of fine material washed from the uplands into the depressions. The impervious character of the subsoil prevented underdrainage from these depressions and the decay of vegetation which grew luxuriantly under the existing swampy conditions resulted in the accumulation of large quantities of organic matter. Near the margins of some of the areas of Miami black clay loam small elevations locally known as "clay knobs" occur. The soil here was not subjected to the same swampy or poorly drained conditions and therefore carries less organic matter and is lighter colored. When large enough to be mapped they were classed as Miami clay loam. The type as it occurs along the small streams and in draws usually contains a larger amount of sand and silt, the result of recent wash, and is therefore more friable and loamy, and easier to work.

When thoroughly drained this type becomes very productive, capable of producing large yields of corn, oats, and hay. The best results seem to have been secured in the production of corn, which yields from 40 to 75 bushels an acre. Oats often produce too heavy a growth of straw, but under favorable conditions may yield from 30 to 40 bushels per acre. Hay yields from 1½ to 2 tons per acre. Clover frequently fails to survive the second winter on account of the heaving to which this type of soil is prone. The type is usually permitted to remain only a short time in sod. The price of the Miami black clay loam varies from $50 to $100 an acre, depending mainly upon the improvements in drainage, the most important factor in the cultivation of this type.

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The following table gives the results of mechanical analyses of the soil and subsoil:

Mechanical analyses of Miami black clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19971	Soil	0.2	2.3	3.1	12.6	10.2	51.1	20.1
19972	Subsoil	.5	1.6	2.0	11.0	9.4	52.1	22.7

CLYDE FINE SANDY LOAM.

The Clyde fine sandy loam consists of 10 to 15 inches of a dark-gray or black material, varying in texture from a fine sandy loam to a fine sand, underlain to 36 inches or more by a dark-gray or black fine sandy loam or loam. The relatively high percentage of organic matter present renders the type a loamy, mellow soil, very productive and easy to cultivate.

The type is of limited extent, the largest areas being found near New Haven and in the prairie southwest of Fort Wayne, with a few other scattered patches in the northern part of the county. It is closely associated with the Dunkirk fine sand, being practically the same in origin. These two types were deposited at the same time, but the material forming the Clyde fine sandy loam fell in deeper water, and these lower places afterwards remained longer in a swampy condition than the shallower portions of the former lake bottom. These long-continued swampy conditions were favorable for the accumulation of organic matter, and hence the reason for higher organic content of Clyde fine sandy loam. The surface is slightly undulating and for the most part the natural drainage is good.

The Clyde fine sandy loam is admirably adapted to the production of small fruits and vegetables, and areas near markets are mostly devoted to these crops. It is also a good corn and grass soil.

The results of mechanical analyses of the soil and subsoil of this type are shown in the following table:

Mechanical analyses of Clyde fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19957	Soil	0.3	1.7	4.7	50.1	14.4	21.6	7.4
19958	Subsoil	.6	1.5	3.8	33.9	17.5	27.6	14.7

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CLYDE LOAM.

The Clyde loam consists of a dark-brown or black loam or clay loam, from 8 to 12 inches deep, underlain to 36 inches or more by a gray, drab, or yellowish clay or clay loam. There is usually no coarse material in either the soil or subsoil, but in section 18, Jackson Township, there is a small area which consists of a heavy, medium, black sandy loam with numerous small shells strewn upon the surface, and underlain by a sticky, gray coarse sand. It represents a reclaimed swamp area and is a little darker colored than the remainder of the type.

The Clyde loam is most extensively developed in the northern part of the Lake Maumee Basin. It forms an almost continuous strip of varying width, immediately south of the north shore line of this glacial lake bed. Other smaller areas occur as depressions in the prairie and elsewhere in the county. The natural drainage is poor, but most of it has been improved greatly by the construction of large open ditches and tile drains.

The formation of the Clyde loam has taken place under practically the same swampy conditions as the Clyde clay. The wash from the sandy beach line and the finer material brought down by the streams from the uplands have become mingled with the soil, giving it a loamy texture. It is therefore more easy to cultivate than the Clyde clay, does not clod or heave as much, and is better adapted to small grains. Most of the type is drained and under cultivation, all the varied farm crops of the county being grown to greater or less extent. Corn, the leading crop, gives yields of 40 to 75 bushels, wheat 15 to 30 bushels, oats 30 to 60 bushels, and hay 1 to 2 tons per acre. Cabbage, onions, sugar beets, and potatoes are grown successfully, but only in a limited way. The poorest drained areas are still uncleared and support a heavy growth of elm, ash, oak, and hickory.

The results of mechanical analyses of the soil and subsoil of this type are shown in the following table:

Mechanical analyses of Clyde loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19953	Soil	0.4	3.8	5.6	20.8	15.5	34.1	19.6
19954	Subsoil	1.3	5.6	6.3	18.9	14.3	33.5	20.1

CLYDE CLAY.

The Clyde clay consists of 6 to 10 inches of drab, black, or dark-brown clay, underlain to a depth of 3 feet or more by a drab or

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yellow, often mottled, plastic and impervious clay. There is only a very small percentage of fine sand present in the soil and its tough, waxy character makes it a difficult type to work. When wet the soil is plastic and tenacious, but when dry the surface breaks into small cubical blocks about one-fourth inch in diameter, and deep cracks, 2 to 4 inches wide, sometimes extend several feet below the surface. The soil contains a large amount of organic matter and where well drained after cultivation for a time becomes more pulverulent, appearing more like a clay loam. Near Muck areas there is usually a few inches of mucky material overlying a heavy drab clay; this phase supports a luxuriant growth of Bermuda grass.

The Clyde clay stands second among the soils of Allen County. It is found principally in the eastern part of the county, where it occupies the large glacial lake depression known as the Maumee Lake Bottom. It is therefore lacustrine in origin, consisting of reworked glacial till laid down in quiet lake waters and after the recession of the lake subjected to wet, swampy conditions for a long period. The lake bed embraces about 100 square miles of territory in Allen County and extents east into Ohio. It is V-shaped, with the apex at New Haven. Good-sized areas also occur in the level prairies southwest of Fort Wayne, to the southeast of Hoagland, and in Adams Township. Smaller bodies occur in the northern part of the county. The surface features are flat or slightly undulating, broken here and there by a low sand or gravel ridge or by a stream depression.

Owing to the general level topography and the heavy texture of the soil, together with its low-lying position, artificial drainage is necessary to cultivation. Large open ditches usually parallel the roads and carry off the water conveyed to them by numerous tiled laterals. The natural drainage in the northern part of the Maumee Lake Bottom is slightly better than in other parts, and having been cultivated longer the soil in this section is in a better state of tilth than the rest of the type.

More care is required in handling the Clyde clay than any of the other soils of the county. If plowed when too wet or too dry it breaks up into large irregular clods which can be pulverized with difficulty. During a very wet season crops suffer from excessive moisture, but with an average amount of rainfall or less large yields of corn, oats, and hay are secured.

Corn is the principal crop grown and the type is the recognized corn soil of the county. The average yields in favorable seasons range from 60 to 75 bushels per acre, while 100 bushels is not an uncommon yield. On well-drained fields oats yield from 30 to 50 bushels. Wheat is seldom grown, on account of injury from the heaving of the soil in winter. The type is well adapted to grass, and from 1½ to 2½ tons of hay per acre are sometimes secured. Sugar

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beets are being successfully grown in the eastern part of the county, the yields ranging from 8 to 12 tons per acre. It is well adapted to this crop, but on account of the scarcity of suitable labor sugar beets are not grown extensively at present.

The Clyde clay is the heaviest and strongest soil of the area, and taken as a whole commands the highest price. Condition of drainage has especial influence on the value. Land having well-established systems of drains range in price from $100 to $150 and more an acre.

The following table gives the results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Clyde clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19961	Soil	0.8	4.9	3.2	12.5	4.4	46.4	27.9
19962	Subsoil	.7	1.7	2.7	7.1	5.2	46.5	35.5

DUNKIRK FINE SANDY LOAM.

The Dunkirk fine sandy loam consists of 8 to 15 inches of light-brown fine sandy loam, underlain to a depth of 36 inches by a brown or yellow silty loam or fine sandy loam. It is closely associated with the Dunkirk fine sand, and near the contact of these types the soil is a loamy sand, deeper and much lighter in texture than the typical soil.

Of limited extent, this soil is found principally along the shore lines of the ancient lakes. It occurs as long, narrow ridges from 2 to 10 feet high, and also in a small way as gently rolling areas. In the northern part of the county, along the northern edge of the Lake Maumee bottom, numerous other areas occur which have the form of eskers. It is derived mainly from reworked glacial material piled up in the old lake beaches. Since that time it has been somewhat modified by wind action and shifted about so as to form low sand dunes. Owing to its texture it is naturally well drained.

With an average amount of rainfall this porous, easily cultivated soil gives good yields of the general farm crops, but during very dry seasons the crop yields are cut short for lack of moisture. Corn averages from 40 to 50 bushels, oats from 25 to 30 bushels, and wheat 15 to 25 bushels per acre. It is a splendid clover soil. Alfalfa has been successfully grown, and the acreage of this legume could be profitably increased. Several fine orchards were noticed, and besides the tree fruits, small fruits are successfully grown. Potatoes and all vegetables adapted to the climate do well.

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The following table gives the results of mechanical analyses of the soil and subsoil:

Mechanical analyses of Dunkirk fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19969	Soil	0.7	4.4	9.4	25.7	12.3	34.1	13.4
19970	Subsoil	1.2	3.6	5.9	14.9	14.3	43.0	16.7

DUNKIRK FINE SAND.

The soil of the Dunkirk fine sand consists of a light-brown loam or yellow fine sand, with a depth ranging from 6 to 10 inches. The subsoil is a yellow, loose, incoherent fine sand, which extends to a depth of 36 inches. In the few inches at the surface there is enough organic matter, together with fine material, to make the soil loamy in texture and somewhat more coherent than the subsoil. It is an easy soil to plow and cultivate.

The Dunkirk fine sand is limited in extent, the largest bodies being situated in the vicinity of New Haven, around Fort Wayne, and in the southern half of the "prairie" lying southwest of the city. It also occurs along the larger stream courses in the northern half of the county. The type is developed as ridges, rounded hills, and knolls from 2 feet to more than 30 feet in height, and possesses excellent natural drainage. These islandlike bodies vary in size from knolls containing a few acres to long, narrow ridges many acres in extent.

In origin this soil is traced directly to reworked glacial débris, carried into the old lakes and assorted by wave action and piled up along the shores as beach lines. Later these beaches have been considerably modified in extent and shape by wind action and the resulting sand dunes are often found some distance from the original position of the material.

Owing to its limited extent, the type is of little agricultural importance in Allen County. Its open, porous nature and thorough drainage, however, make it a typical early truck soil, and this is the class of farming usually followed. In the vicinity of Fort Wayne it is devoted almost exclusively to market gardening, and all kinds of vegetables, melons, and small fruits are successfully grown. Peaches and apples produce a fine-flavored fruit. Any crop requiring a light sandy soil will do well upon the Dunkirk fine sand. The native timber growth is oak and the greater part of the type supports a good growth of grass. The subsoil is valuable as a building sand and is used considerably for construction purposes.

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The following table gives the results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Dunkirk fine sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19967	Soil	0.1	0.8	5.1	70.0	10.5	8.7	4.6
19968	Subsoil	.0	.7	5.6	73.4	9.0	8.8	2.4

DUNKIRK SANDY LOAM.

The Dunkirk sandy loam to a depth ranging from 10 to 15 inches consists of a medium to fine sandy loam varying in color from gray to brown or reddish brown. This surface material is underlain to a depth of 3 feet by a reddish-brown sandy loam or sandy clay which acts as a cement or matrix holding together a large quantity of coarse sand and fine gravel. Frequently fine gravel is found strewn upon the surface, but not in quantities great enough to interfere with cultivation.

Immediately underlying the subsoil beds of gravelly clay varying from 2 to 4 feet in thickness often occur, and below these are frequently found beds of a purer gravel, usually from 4 to 10 feet in thickness. Nearly all of the sand and gravel used in the county for road material and railway ballast have been taken from these gravel pits, and the exposures thus made afford an excellent opportunity for studying the arrangement of the deeper strata underlying this soil.

The texture of the Dunkirk sandy loam varies greatly in different parts of the county, but the subsoil possesses great uniformity. In Perry and Cedar Creek townships, for example, the soil contains a larger proportion of medium to coarse sand than in other parts of the county, while south of Fort Wayne the soil is composed of a compact fine sandy loam or light-textured loam. In the eastern half of the county the type is composed largely of a medium-textured sandy loam.

The Dunkirk sandy loam occurs as gently rolling country, terraces, isolated knolls, and detached ridges, and possesses excellent drainage. It is typically developed in the ridges which represent the old beach lines of Lake Maumee. The ridge running northeast from Fort Wayne, along which the Maysville wagon road extends, formed the north shore of this glacial lake, and the Van Wert wagon road follows a ridge which represents the south shore of the lake.

The general farm crops of the region are grown upon the type, but wheat is given preference, as the soil is recognized as one of the best in the county for that crop. Corn, oats, and hay are also grown. The yields of wheat range from 20 to 30 bushels, of corn from 50 to 75 bushels, oats from 30 to 40 bushels, and hay from 1½ to 2 tons per acre.

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All kinds of market-garden crops and small fruits do exceptionally well. It is considered the best orchard soil of the area, peaches, apples, and cherries producing fine, well-flavored fruit. It is also an excellent potato soil.

The following table gives the average results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Dunkirk sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19979, 19981	Soil	1.8	9.8	18.4	40.8	5.8	17.6	6.0
19980, 19982	Subsoil	5.1	12.7	12.4	30.5	4.1	21.5	13.2

WABASH FINE SAND.

The Wabash fine sand to a depth of about 15 inches consists of a brown fine sandy loam or loamy sand. The subsoil is lighter than the surface soil both in color and texture, and at a depth of 2 feet frequently grades into a gray or yellow fine sand. The soil is friable and easily cultivated.

Most of this soil, which is of only limited extent, is found along the St. Joseph River in Cedar Creek Township and along Cedar Creek in sections 19 and 20 of the same township. A few scattered areas also occur along the Maumee River between New Haven and Fort Wayne. It is of alluvial origin and confined to the flood plains of the larger streams. The most typical areas occur upon the inner bends of the streams and adjacent to the stream courses. The type is frequently overflowed, and each successive flood leaves a thin deposit of fine sand and organic matter upon the surface. The areas consist of low, sandy knolls, ridges, and old stream channels, and except in flood times they are fairly well drained.

Corn is the principal crop, and in favorable seasons the average yield ranges from 40 to 75 bushels per acre. On the higher, better drained areas some oats and wheat are grown and fairly good yields are produced. Truck crops also do very well on this type of soil.

The following table shows the results of mechanical analyses of the soil and subsoil of Wabash fine sand:

Mechanical analyses of Wabash fine sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19987	Soil	0.0	0.4	3.9	59.4	12.8	18.2	4.4
19988	Subsoil	.0	.2	4.9	61.7	12.7	14.5	5.0

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WABASH SILT LOAM.

The Wabash silt loam is usually a brown silty loam, about 10 inches deep, underlain to a depth of 36 inches or more by a lighter-colored material of the same texture as the soil. The texture of the type as a whole, however, is quite variable, depending upon distance from the stream channel and the character of the soils upon the hills of the surrounding country. Near the present stream channel there is usually increased sand content, while in some of the depressions farther from the stream there is enough clay present to approximate the standards of a clay loam.

Little of this soil is found in Allen County. It occurs mainly along the bottoms of St. Joseph, St. Marys, and Maumee rivers. It is an alluvial type, and owes its origin to material washed into the streams from the hills and deposited along the bottoms at times of overflow. It is found principally in the oxbows of these larger streams, although narrow strips are found along both the main and the smaller streams where the channels are less crooked. The type is subject to overflow, and occupies the level or flat first and second terraces or bottoms. The underdrainage is good, so that crops do not usually suffer from excessive moisture, except at times of high water, and the fields are soon in condition after the floods subside.

The Wabash silt loam contains a large percentage of organic matter and is a strong, productive type. Corn is the principal crop, and during favorable seasons yields from 50 to 75 bushels per acre. Higher lying, better drained locations are often planted to wheat, and have yielded as high as 30 bushels per acre. Oats yield from 25 to 40 bushels and hay 2 tons per acre.

The results of mechanical analyses of soil and subsoil of this type are given in the following table:

Mechanical analyses of Wabash silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19983	Soil	0.0	0.9	0.8	4.8	8.4	64.8	20.0
19984	Subsoil	.0	.5	.7	5.7	9.7	62.1	20.9

WAVERLY SILT LOAM.

The Waverly silt loam consists of a light-gray or brown silt loam from 8 to 12 inches deep, resting on a subsoil of yellowish-brown silty clay, becoming somewhat heavier as the depth increases, but extending without material change below the limit of the borings, which are made to a depth of 36 inches.

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The type is of very limited extent and is rather variable in texture. It occupies narrow strips or small areas along the Maumee River, from 10 to 12 feet above the present flood plain, and seldom extends back more than one-fourth mile from the stream. The most typical area occurs north of New Haven, along the north bank of the Maumee River. The other areas were mapped southwest of New Haven, in what is known as the New Haven delta. These areas contain more fine sand and coarse silt in the surface soil than is usual for the areas adjacent to the river, and the color of the soil is also darker, owing to the presence of slightly more organic matter.

In surface features the Waverly silt loam is nearly level, with a gentle slope back from the stream, where the silt gives way to heavier material. It is usually deficient in organic matter, and the soil when wet becomes quite sticky. The soil is best suited to grass, and is seldom planted to corn on account of small yields. Wheat and oats do fairly well.

The following table gives the results of mechanical analyses of typical samples of the soil and subsoil of this type:

Mechanical analyses of Waverly silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19985	Soil	0.0	0.7	0.8	2.1	7.6	64.7	23.8
19986	Subsoil	.0	.7	.7	2.4	7.3	62.1	26.4

MUCK.

The Muck consists of a mass of dark-brown to black more or less decomposed vegetable mold, usually 3 feet or more in depth, though in places it may be only a few inches deep. The color of the material sometimes becomes reddish brown at some distance below the surface, and at this and lower depths coarse and fine vegetable fibers often become noticeable. Beneath this mass of organic material there is found a light-blue or drab clay, which in places is somewhat sandy. Along the margins of the larger areas and bordering the banks of the open ditches considerable fine sand and silt have become incorporated with the Muck. In the northeastern part of the county a number of the Muck areas have a reddish-brown fine fibrous substance with which there is mingled but a small amount of mineral matter. This phase represents the transition stage between Peat and true Muck. As these areas are closely associated with the more typical Muck areas and become darker with cultivation and more thoroughly oxidized when exposed to the air, they have been mapped as Muck. Other areas of Muck occur as isolated patches from one to many acres in extent in the intermorainic plain which extends diag-

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onally across Lake, Eel River, and Perry townships. Long, narrow strips of Muck also occur along what were probably small stream channels during glacial times, and all of the present lakes of the area are surrounded by narrow fringes of the type.

Occupying depressions the Muck areas are level and flat and possess poor natural drainage. They receive the drainage from higher ground, and often, even in times of drought, the water table is very close to the surface. Artificial drainage is therefore necessary before cultivated crops can be successfully grown. A great deal of good has been accomplished by the construction of large open ditches, into which lateral tile drains and open ditches empty, but much yet remains to be done in this direction. Muck areas represent depressions of various kinds in which there has been a great accumulation of organic matter resulting from the decay of the plants which have grown in these wet places. The degree of the decomposition is the distinguishing feature between Muck and Peat, the former representing a more advanced state of decomposition than the latter. Along the margins of the larger areas and bordering the banks of the open ditches a considerable amount of silt and fine sand is mixed with the organic matter. This is either a result of overflow in the ditches or of wash from higher ground.

Many of the Muck areas support excellent pasturage, but the greater part of the type is covered with a dense growth of golden-rod, coarse grasses, and willows. Corn is grown on the better drained areas and when not injured by rains or early frosts yields from 60 to 100 bushels per acre. The quality of corn, however, is inferior to that grown upon the other soil types. Large yields of potatoes are secured on the Muck areas, but they are usually inferior in quality. The areas having considerable sand and wash material mixed with the mucky surface produce larger yields and a product of better quality. Cabbage, onions, celery, and peppermint are grown to a limited extent and considering the abundant yields it is surprising that these crops are not grown more extensively.

In handling Muck soils it has frequently been found that they can be considerably improved by the use of coarse barnyard manure, and also by the use of straw or other coarse litter, which should be thoroughly incorporated with the Muck. Throughout the central States it has been found that commercial fertilizers, containing a large percentage of potash salts, are especially beneficial upon Muck and Peat soils. A fertilizer establishment located near Fort Wayne uses Muck as a filler in the mixing and preparation of its fertilizers.

PEAT.

Peat consists of 3 feet or more of coarse brown vegetable fiber more or less permanently saturated with water. When thoroughly drained

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and tilled the fibrous material readily breaks up into a fine powder closely resembling snuff both in texture and color. It contains practically no mineral matter and when dry burns readily, often to a depth of several feet.

Only a few typical areas of Peat occur in Allen County, but where possible these were separated from Muck. The largest body of the type occurs southwest of Fort Wayne in the "prairie." A portion of this area is under cultivation, potatoes being almost exclusively grown. In favorable seasons, when the rainfall is below the average, potatoes yield from 150 to 300 bushels per acre, though over 400 bushels have been grown on an acre. The quality, however, is generally poor. Less than a half dozen other small patches of Peat occur and these are all confined to the northern part of the county. They are not cultivated, but support a dense growth of weeds, bushes, and aquatic plants, and also a few elm trees.

MEADOW.

The Meadow of this area includes the usual type of wet, low-lying narrow strips of waste land along the smaller streams, and also a few low-lying areas in the uplands.

The soil of the Meadow strips is variable, but for the most part is a dark-colored clay or clay loam. Where the Meadow is swampy there is usually found a coating of Muck, a few inches in thickness. In depressions the soil is a heavy black clay upon which water stands the greater part of the year. These areas if reclaimed by proper drainage would in time become similar to the Miami black clay loam. Most of the Meadow areas are unfit for cultivation at present and are left in timber and grass.

SUMMARY.

Allen County is located in the northeastern part of the State of Indiana. The surface features vary from the nearly level prairie-like areas of the glacial lake beds to the gently rolling and hilly country of the terminal moraines.

The average elevation above sea level is about 800 feet. The county has an area of about 667 square miles or 426,880 acres.

Allen County was organized in 1823, but not until the decade of 1840–1850 was there a marked influx of settlers.

The yearly rainfall ranges from 31 to 52 inches, with a mean of 38.7 inches. The absolute maximum temperature is 104° F., absolute minimum —25° F., and annual mean 49° F.

The drainage is principally into Lake Erie through the Maumee River and its tributaries. The western part of the county drains into the Wabash through Eel River, Aboite and Little Prairie creeks, and their tributaries.

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The agriculture of Allen County is in a prosperous condition. Corn, wheat, oats, clover, and timothy are the principal products. Dairying and live-stock raising are practiced only in a limited way.

The importance of crop rotation is recognized, though no system is strictly adhered to. Stable manure is widely used. Farm labor is paid $15 to $30 per month, with board.

The average size of farms is about 90 acres and over one-half of them are operated by the owners. Most of the land in the county is improved. Value of farm land ranges from $50 to $100 an acre for the clay uplands to $100 or $150 an acre for the best drained and improved bottom land.

A number of steam and electric railways give ample transportation facilities for all parts of the county.

Fourteen soil types were recognized in this survey. These are all composed of glacial material and range from sand to clay. The light-colored soils represent the well-drained drift materials, while the dark soils are those which have remained in a swampy or poorly drained condition for a considerable period. The Miami series with two members and the Dunkirk series with three represent the light-colored soils. The Clyde series embraces the dark-colored glacial lacustrine soils with three members. Of the alluvial soils two belong to the Wabash and one to the Waverly series. Muck, Peat, and Meadow are the three remaining types.

The Miami clay loam is the predominating type. It is the general-purpose soil of the county, and constitutes more than one-half of the area of the county.

The Miami black clay loam when properly drained produces large yields of corn and grass.

The Clyde soils are best suited to corn. They require artificial drainage, and deep plowing in the case of the clay would increase the crop yields. Clyde clay is a very desirable soil for sugar beets, and their acreage could be profitably extended.

The Dunkirk soils are best suited to crops requiring a light, sandy soil. The fine sand is an ideal soil for early truck. Most of the market-garden produce consumed in Fort Wayne is grown upon this type. The sandy loam is the best wheat soil, and apples do exceptionally well upon it. The gravel subsoil of this type is used for road-surfacing material.

Of the alluvial soils, the Wabash fine sand and silt loam are subject to frequent overflow, but in favorable seasons produce large yields of corn and grass. The Waverly silt loam is deficient in organic matter and is best suited to grass.

Peat and Muck when thoroughly drained produce abundantly of corn and potatoes, but the yield of corn is usually light and chaffy

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in quality. Special crops, such as celery, onions, and peppermint, should prove remunerative. Meadow land is best suited to pasturage.

The light-colored soils are in need of humus. Manure and catch crops turned under for green manure should be more extensively used. Much clover is grown for hay and seed, but more of it should be fed on the farm and returned to the soil as manure. Alfalfa has been successfully grown upon the Miami clay loam and the Dunkirk sandy loam. It is an ideal forage crop for all stock and a splendid soil renovator. It should be more extensively grown.

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SOIL SURVEY OF BATES COUNTY, MISSOURI.

By CHARLES J. MANN, ALLEN L. HIGGINS, and LAWRENCE A. KOLBE.

DESCRIPTION OF THE AREA.

Bates County is situated midway of the western boundary of the State of Missouri. It is bounded on the north by Cass County, on the east by Henry and St. Clair counties, on the south by Vernon County, and on the west by Linn and Miami counties, Kansas. Its southern boundary lies about 4 miles north of parallel 38° north latitude, and meridian 94° west from Greenwich passes about 4 miles

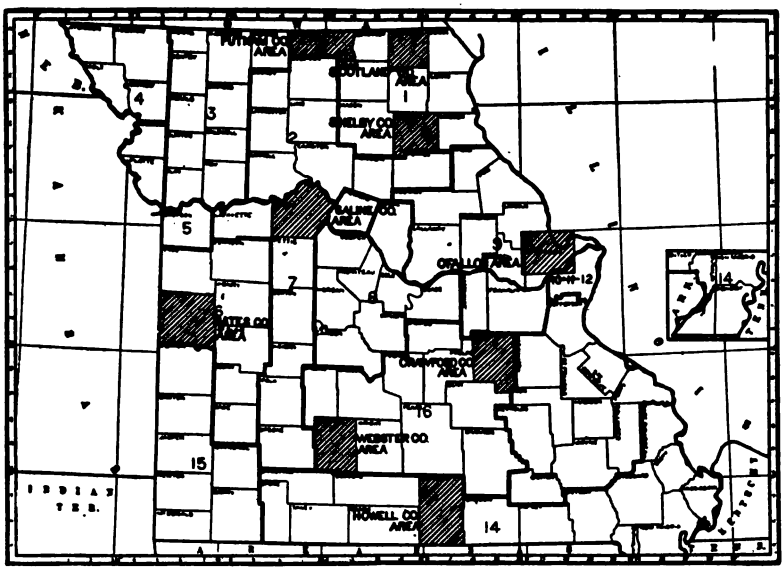

FIG. 31.—Sketch map showing location of the Bates County area, Missouri.

east of the eastern boundary. The county has a length north and south of about 30 miles and a width approximately the same, and comprises 554,240 acres, or 866 square miles.

Topographically Bates County consists of three terraces, each of which is more or less dissected by valleys. The lowest terrace is in the southeastern part of the county and the highest in the northwestern part. The average elevation of the lowest is about 650 to 700 feet, the middle one about 800 to 850 feet, and the upper one about 1,000 feet above sea level. The highest one has the smallest extent and the middle one the greatest. In fact, by far the larger part of the county is included in the latter. Its eastern boundary runs from

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Rich Hill nearly eastward to a point 2½ miles south of Pleasant Gap, thence northeastward to the offset in the county line at the southwestern corner of Henry County. Its western boundary runs from the Kansas line near Amsterdam northward to Merwin, thence about eastward to near Adrian, thence northwestward to the northern boundary of the county, about 6 miles east of the northwest corner. At its eastern boundary this terrace drops rather abruptly about 150 feet to the lowest terrace, and its western boundary is the abrupt rise of about 150 feet to the highest terrace. The eastern border of this middle terrace is much dissected by deep valleys of streams that flow from it out into the lower terrace. The cut is much deeper into it than into the lower terrace, because it is so much higher than the latter. Westward and northwestward from the eastern boundary the valleys are more and more shallow, until along the northwestern border of the terrace there is a belt that is barely cut by valleys at all. In fact, there are considerable areas along it that are not well drained.

Only the northwestern part of the lower terrace lies in Bates County, the rest of it lying to the eastward. The whole of this area therefore is smooth. Its valleys are very shallow, even that of the Osage River; it is a gently undulating plain. Only the eastern border of the third terrace lies in this county. The most of it is a high dissected plateau. It is like the eastern border of the middle terrace in roughness, but is higher.

As there has been no faulting or folding of the rocks, the surface features of Bates County are the direct result of erosion. This has acted in proportion to the relative resistance of the interbedded shales, sandstones, and limestones composing the region and has left low, well-marked terrace lines and mounds which form the only prominent topographic features of the area. Except for an occasional sandy knoll or low ridge, the numerous and extensive shale horizons are characterized by level or undulating topography, which gives way to more rolling relief where the underlying limestone has been exposed. Along the streams, particularly in the limestone region, the land is usually quite broken and rough, though there are occasional long, gentle slopes in which it is frequently difficult to determine the limit of overflowed land.

There is a total range in elevation of over 300 feet. The lowest point where the Osage River leaves the county at the southeast corner is less than 700 feet and the highest, which is in the northwest corner, is over 1,000 feet above sea level.

This western prairie region is noted for its many stream channels. The greater part of the drainage of the county is carried by Miami Creek, which rises in the northwest corner and flowing southeast empties into the Osage River in the south-central part of the county. This river enters the county 3 miles south of the middle of the west

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county line and receives nearly all the drainage of the southwestern third of the county. Two and one-half miles south of Papinsville it is joined by the Marmiton River. From this point eastward it forms the south county boundary line.

Most of the northern part of the county is drained by Mormon Fork Creek, a tributary of the Grand River which forms part of the north county line. The east-central part is drained by Deepwater, North Deepwater, and South Deepwater creeks and their many tributaries.

The first settlement was at Harmony Mission in 1821, and near where Papinsville now stands. The next settlement was in Shawnee Township, about the year 1830. Most of the early settlers came from Kentucky, Tennessee, and Virginia, although some were from the Northern States. Bates County was organized in 1841 and its present boundaries established in 1855, at about which time there was considerable immigration to this region.

The county was in fairly prosperous condition when the civil war broke out in 1861, but being on the border was made the subject of attacks from both sides until nearly everyone left the county. After the war the majority of the former residents returned and were soon followed by new settlers from Ohio, Indiana, Illinois, and Iowa.

The population, which is given by the Twelfth Census as 30,141, is largely rural and well distributed. Rich Hill, with a population of a little over 4,000, is the largest town and receives considerable support from the adjacent coal mines. It is located in the southern part of the county, on the Missouri Pacific Railway and a branch of the Frisco system known as the Kansas City, Fort Scott and Memphis Railroad.

Butler, the county seat, is nearly as large as Rich Hill and is situated on the Missouri Pacific Railway near the center of the county. The small town of Rockville is situated on the Missouri, Kansas and Texas Railway, in the southeastern part of the county. Merwin, Amsterdam, Amoret, and Hume are towns of from 200 to 600 inhabitants, situated on the Kansas City Southern, in the western part of the county. Besides these there are several small villages throughout the county.

There are nearly 100 miles of railroad in the county and all sections except the northeastern have fairly good shipping facilities. The Missouri, Kansas and Texas Railway crosses the southeastern corner; the Missouri Pacific traverses the county from north to south near the center, and a branch of this system known as the Interstate runs in a general southwest direction from Butler. The Kansas City Southern crosses the county from north to south near the western border.

Kansas City, 75 miles north, is the great market for grain and live stock and is reached direct by the three main roads. St. Louis, 225 miles east, is also easily reached over the same routes. The wagon

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roads throughout the county are in fairly good condition a large part of the year. The rural free delivery of mail is in operation in practically all parts of the county, and nearly all the farmers have telephones.

CLIMATE.

Bates County has a distinctly humid climate. The precipitation is relatively light from October to March, inclusive, and is heaviest during the crop-growing season, from April to September, inclusive. There is sometimes a deficiency of rainfall during the latter part of July and August, and corn at such times may suffer unless special care is taken to conserve the soil moisture.

The winters are comparatively mild and open, although occasionally the temperature may fall below zero for a few days at a time. The average annual snowfall is about 20 inches. The snow is seldom very deep and rarely remains on the ground for any length of time. The length of the growing season averages about 157 days.

The following table, compiled from the records of the Weather Bureau station at Harrisonville, 28 miles north, in the adjoining county of Cass, represents approximately the climatic conditions of Bates County.

Normal monthly, seasonal, and annual temperature and precipitation at Harrisonville.

Month.	Temperature.			Precipitation.			
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year.	Total amount for the wettest year.	Snow, average depth.
	°F.	°F.	°F.	Inches.	Inches.	Inches.	Inches.
December	31	74	−16	2.0	0.4	1.0	2.8
January	27	70	−20	1.4	1.2	.4	4.8
February	29	81	−28	2.1	1.2	3.4	6.2
Winter	29	.....	.....	5.5	2.8	4.8	13.8
March	40	92	1	2.6	.9	3.4	3.8
April	54	96	15	3.5	2.0	7.4	1.1
May	64	94	28	4.7	2.6	4.6	.0
Spring	56	.....	.....	10.8	5.5	15.4	4.9
June	73	104	41	4.4	2.2	12.2	.0
July	78	112	52	3.9	3.5	10.7	.0
August	75	108	45	4.2	5.3	6.4	.0
Summer	75	.....	.....	12.5	11.0	29.3	.0
September	68	107	29	4.0	1.3	8.1	.0
October	56	96	21	2.6	2.1	9.7	.4
November	42	79	0	2.1	1.6	.0	.5
Fall	55	.....	.....	8.7	5.0	17.8	.9
Year	54	112	−28	37.5	24.3	67.3	19.6

Average date of the last killing frost in spring is April 13, and of the first in fall October 18.

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AGRICULTURE.

The agricultural history of Bates County is very similar to that of the entire western prairie section. The pioneers found an exceedingly rank growth of prairie grass covering vast areas, broken only by narrow belts of timber along the larger stream courses. As they needed lumber for building, wood for fuel, rails for fences, and water for general purposes, they settled along the streams, where timber and water were available. Wild fruit, game, and fish were also abundant in such locations.

A few acres of timber were cleared, the product utilized, and the land planted to corn. Usually some adjacent prairie land was broken and also planted to corn. Wheat, too, was one of the first crops. Spring wheat was tried at first, but soon gave way to the winter variety. Mills for grinding the wheat and corn were early established along the streams in different parts of the county. It is claimed that the yields of grain were practically the same from the virgin soil as they are at present, the conclusion being that improved methods of the present have about compensated for the greater original fertility of the soil.

Agriculture was completely demoralized during the closing years of the civil war, and in the late sixties more than half of the land was advertised for sale to pay taxes. But with the close of the war many of the northern soldiers who had seen the country and most of the former inhabitants returned, and farm operations began with increased vigor. By 1868 about 10 per cent of the land was in cultivation and the acreage cultivated has increased rapidly until now only a very small percentage remains unbroken.

In the early seventies chinch bugs became a serious pest and by 1874 wheat had been practically abandoned because of them. In the fall of 1874 swarms of grasshoppers appeared and literally cleared the country of all vegetation, leaving the farmers in such a condition that outside help was necessary to relieve the suffering. The grasshoppers came again in the spring of 1875 and destroyed the young crops, but they disappeared in June; corn was again planted, and the crop of that year was the biggest on record.

The chinch bugs had been starved out by the grasshoppers and the land was cleared of weeds, which, together with the abundant and well-scattered rainfall, made conditions reassuring for crops. With the disappearance of the chinch bugs wheat was generally cultivated until about 1880, when the bugs again became numerous and the crop became of minor importance. The years 1901 and 1902 were unfavorable to the chinch bug and it was practically exterminated. Since that time wheat has regained its former importance.

With the extensive free range it was natural that stock raising should early become an important industry. The cattle were raised

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and largely fattened on the range, though they were fed what corn was available, as this was the only way in which corn could be easily marketed. Prior to 1870, when the Missouri, Kansas and Texas Railway was built, giving connection with the St. Louis markets, stock was driven 50 miles north to Pleasant Hill and there shipped to Kansas City. With the shipping facilities provided by later railroads, young stock was shipped into the county and turned into fenced pasture and later fed for market. This industry continues to be one of great importance in the county.

Some of the early settlers who came from the south tried cotton growing and a gin was at one time in operation, but cotton has long since been abandoned because of its uncertainty. Castor beans, at one time produced to some extent, were abandoned chiefly on account of the great amount of labor involved in handling the crop. Clover at first did not seem to do well, but in recent years it has gained in favor rapidly. Flax has been grown for many years, though the acreage has declined and it is not now one of the important crops. Oats apparently reached their maximum production in 1870, when the acreage was about 32,000 and the average yield per acre over 25 bushels. In recent years the area sown has been about 14,000 acres. Broom corn is still grown in certain localities, but is not nearly as important a crop as it was formerly. Lately the acreage of sorghum and Kafir corn has been increased somewhat. Tobacco has been grown for home use for many years, and present indications are that it may become a commercial crop. Alfalfa and cowpeas are comparatively new crops which are certain to be general crops in the near future. Indian corn is and always has been the most important and main money crop of the area. It has been grown in the same fields continuously as long as a profitable yield could be obtained. As the crop is almost entirely fed to stock no particular varieties are given preference and but little effort has been made to improve the strains by seed selection. Seed corn is usually picked out of the crib, and though some effort is made to select the best-looking ears this method must necessarily result in ultimate deterioration of the product. There are fortunately a few farmers who are paying more attention to varieties and who are employing modern methods of seed selection. Of yellow corn, Ried's Yellow Dent is preferred by some, and of the white varieties the Farmer's Interest and St. Charles White. The greater part of the crop is drilled in rows about 4 feet apart and 15 inches between kernels, but the best farmers condemn this practice and prefer the check-row method in order to permit more thorough cultivation. As it is important to keep corn clean from weeds and grass, which are certain to injure the crop, there seems to be sufficient reason for discouraging the practice of drilling.

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Modern machinery, including weeders and riding cultivators, frequently the double-row, are in general use in the culture of corn. Late cultivation of the crop with a one-horse implement, it seems, has never been tried, but it is very probable that during short droughts this practice would be found profitable, as much moisture now lost through evaporation would be retained in the soil for the use of the crop. The crop is usually harvested by hand, though the harvester is frequently used, and the fodder shredded and fed to stock. The cornsheller is almost unknown. The small producer disposes of his crop in the ear, or sometimes in the field, to the cattle feeder, who feeds it in the ear. Some corn is occasionally shipped from the county, and this is shelled at the elevators. Probably as much grain is imported for feed.

More money is brought into the county directly from the sale of live stock than from any other source. The larger landowners almost invariably feed stock of some kind, buying much of their grain from tenants or the owners of smaller farms, keeping most of their own land in permanent pasture. Formerly most of the cattle fed were raised in the county, but recently the larger number have been imported in carload lots from Kansas City. These cattle, mostly steers, are grades, though some are of very good quality. The home-grown cattle are usually of Shorthorn or Hereford blood and of excellent quality. Some Angus cattle were also seen. Several pure-bred herds exist in the county, and cattle raising seems to be a thriving industry.

All of the farmers raise hogs, some making it more or less a specialty. Some very fine pure-bred pens were seen. Poland Chinas are probably the most common, though Duroc-Jerseys or Red Rocks are numerous. A few Berkshires and Chester Whites are also seen. A first cross between the Poland China and Duroc-Jersey is very popular with a few farmers, and as has been the experience in other localities this cross is more prolific and makes better feeders than the pure-bred stock.

The raising of horses and mules is quite an industry, and though no single farm is perhaps devoted entirely to this branch the number of farmers who have a few head for sale is large. These are usually bought up by a few men who improve their market condition before shipping them to distant points. The sheep industry is growing, as there is considerable land well suited for pasture.

Dairying is practiced to a limited extent in nearly all parts of the county. Separators are common and only the cream is sold, a ready market for which is found at the creamery in Butler and also at substations in other towns. Notwithstanding the interest in dairying there is only one silo in the county at the present time. There is no more economical way of keeping up the flow and quality of milk

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during the time of year when the cows are not on pasture than by feeding silage.

Winter wheat is a secondary money crop. The most common variety is the Mediterranean, but in a recent test the Poole variety gave somewhat better yields. The crop is usually sowed with a drill by October 1. The chinch bug is not at present a serious pest, and the crop is seldom damaged, except by heaving and occasionally by hail or rust. The use of commercial fertilizers in growing wheat is becoming general. A packing-house brand containing 2 per cent nitrogen, 11 per cent phosphate, and 2 per cent potash is commonly used. The quantity applied ranges from 100 to 150 pounds to the acre. Fertilizer is said to give an increased yield of 5 to 9 bushels per acre. Much of the crop is marketed at the local mills, though some is shipped out of the county.

Timothy and clover constitute the most important hay crop. Timothy seed is usually sowed with the wheat in the fall and the clover in the early spring. Flax is a better crop than wheat to sow with the grass. The hay is nearly all consumed on the farm. There seems to be a tendency to keep the land in meadow longer than the quality of the hay obtained warrants. The pasture and meadow can be maintained in much better condition by mowing the annual weeds, which are abundant, then disking and sowing more seed at the proper time. The amount of feed on many of the pastures could be greatly increased by this method, though many of them should be broken up. Japan clover, *Lespedeza*, was seen growing along the roadsides in many parts of the county, but its value in the pasture seems not to be fully appreciated and more effort should be made to establish it, particularly in sheep pastures.

The oat crop is very uncertain. Occasionally yields of 50 to 60 bushels per acre are obtained, but frequently the crop is not worth cutting. While there are several contributing causes for these failures it is believed that the climatic conditions are largely responsible. The sun frequently scalds the plant during its growth; therefore it is important to get the seed in the ground as early as possible in the spring. Spring frosts very seldom injure the crop permanently. Volunteer oats in the spring are quite common and are reported to mature earlier and make stronger growth than those sowed in the spring. This suggests at once the possibility of creating by selection from these volunteer oats a winter oat for this region which will give surer and better yields than the present varieties. Some improvement could probably be made by seed selection and cleaning and in the preparation of the seed bed. The amount of seed broadcasted and drilled is estimated to be about the same, though from reports it seems that drilling insures somewhat larger yields. The Texas red oat is most commonly grown, though it is said the seed deteriorates rapidly.

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Flax is a secondary crop. The seed is usually drilled in, though frequently sowed broadcast and harrowed or brushed in on very well-prepared land. Timothy and clover is sown with it, for as a nurse crop for grass flax is unequaled. Its open foliage allows more sunshine to reach the young grass than when wheat or rye are used, and the grass suffers less when the flax is removed. It is usually cut, bunched, stacked, and thrashed. The seed alone is sold, no use being made of the fiber. The yield averages about 8 bushels to the acre, and the average price is about $1 per bushel. The straw is commonly fed to stock.

Experience has shown that flax should not be grown on the same land oftener than once in five years, because of the disease known as "flax wilt." Owing to the low yields obtained this crop is not extensively grown.

Some sorghum is grown. It is used in the manufacture of sirup, which is worth about 50 cents a gallon. It is not produced on a large commercial scale. The best quality of sirup is made from sorghum produced on the Oswego silt loam, though a larger yield per acre can be secured from some of the heavier soils.

Kafir corn is grown as a forage crop, and its production is encouraged because it makes an abundance of valuable supplementary feed.

Market gardening is followed by a few farmers, chiefly to supply the local markets. Watermelons are an important truck crop, the Wigger melon being especially popular. The Sweetheart variety is the most common.

Cowpeas are becoming a general crop, particularly on the Oswego silt loam. The Whip-poor-will variety is in most common use. Cowpeas are frequently drilled with a corn planter on wheat stubble in July, cut for hay in October, and the pea stubble immediately plowed under and the land planted to wheat again. This has been found to be very beneficial to the succeeding wheat crop. When cowpeas are harvested for seed they are made the only crop of the year. Some farmers have this year (1908) planted cowpeas in the corn after laying by the latter crop, and this practice is to be commended.

Some impetus is being given to tobacco production. The crop has been grown for years by a few who learned how to grow it in Kentucky, and after settling in this county continued its production. These have for the most part sold their crop at retail, as no market is readily available. A farmer on Miami Creek cultivates a small patch of Golden Leaf, securing about 150 pounds on one-eighth of an acre, which sells for about 20 cents a pound. Another farmer has raised twenty-one crops of White Burley. With heavy manuring it produces from 1,000 to 1,200 pounds per acre, which retails at from 12 to 15 cents per pound. He plants from May 25 to June 15 and harvests in August. He claims that he makes a clear profit of about $75

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an acre on the few acres planted to this crop each year. Land on which timber has grown is considered absolutely essential for tobacco production.

The growing of alfalfa is in an experimental stage. It is being grown to a small extent on several different types of soil in the county. It is safe to predict that alfalfa will in time become one of the important crops of the area. On the uplands inoculation and liming will probably be necessary to secure the most successful yields.

On nearly every farm some orchard fruits are produced for home use. This, however, is not recognized as a fruit region and but one commercial orchard is found in the county.

That certain crops are adapted to certain soil types is fairly well recognized. The truck crops are almost invariably grown on the Bates loam and Boone fine sandy loam. The Summit silt loam and Crawford silt loam or the bottom-land soils are best adapted to corn and are more extensively cultivated to this crop than are any of the other types. Wheat, oats, and grass cover a large acreage on the Oswego silt loam, which is admirably adapted to these crops. Though these adaptations are commonly recognized, they are not always taken advantage of. One reason for this is the absence of systematic crop rotation.

Each farmer should adopt a crop-rotation system which will answer the requirements of his own farm and the different soil types occurring thereon. Soils deficient in humus, like the Oswego silt loam, should have a rotation which will constantly replenish the humus supply, while the physical condition of some of the other types is the important point to be kept in mind in planning the crop rotation.

On a typical grain farm in the county the following system of cropping is practiced: Mowing land is broken in the fall, leaving it exposed in the furrow over winter, and the seed bed prepared in the spring and planted to corn. The cornstalks are broken down after harvest, and if the weather permits the ground is again plowed in the fall and planted to corn the second year. If possible the land is plowed the following fall, but if not the seed bed for oats the third year is prepared by disking and the seed put in as early as possible. The oat stubble is plowed immediately after harvest and as shallow as turning under the stubble will permit. Wheat is planted that fall and also the fall of the fourth year, when timothy seed is sowed with the wheat and the following spring clover seed is also sowed. The land is kept in mowing for two years and then used again for the production of corn. This makes a seven-year rotation which offers opportunities for many variations. The main criticism is that it includes no leguminous crop. Cowpeas could be put in the corn and also after the first wheat crop, and if plowed under would effectually maintain the humus supply of the soil.

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On another farm where a longer rotation is practiced flax is introduced when seeding the land to grass. The entire crop of clover is plowed under in the late summer and no crop is taken off the land that year. It is claimed that the loss of a crop in this way is compensated for by the increased yields of the following crops. Where it is not convenient to follow this plan, catch crops of cowpeas can be introduced and the supply of organic matter maintained in this way.

The average size of farms is about 120 acres, and from the census reports it appears that the percentage of farms operated by owners is decreasing. This is due partly to the fact that some farmers have retired and rented their land and partly to the immense accumulation of land in the Scully estate. Cash rent ranges from $2 to $3 an acre. On a share basis the landlord receives from two-fifths to one-half of the crops on shares. Farming land may be purchased at $25 to $60 an acre, though more highly improved and favorably situated farms are held at the higher price.

SOILS.

Bates County lies within the nonglaciated part of the western prairie region. Its upland soil is therefore residual, or derived from the immediately underlying rock. The rocks of this region belong to the Pennsylvania division of the Carboniferous and consist of interbedded shale, sandstone, and limestone. Shale is the predominating rock and may vary from argillaceous to arenaceous in the different beds or even in the same stratum, while the layers of limestone and sandstone are comparatively thin and uniform. Faulting or folding of these rocks is nowhere in evidence, the strata lying nearly horizontal, with only a slight dip to the northwest. It is apparent that were the present surface level the soil would be practically the same all over the county. Such a condition, however, has been prevented by erosion, the result being that with the differences in elevation the different strata of rock have been exposed to the processes of weathering and soil formation. As the different kinds of rock give rise to widely varying soils, it is easily seen that topography is a very important factor in the location of any particular kind of soil.

Soils of different texture—that is, composed of different proportions of sand, silt, clay, etc., but closely related through source of material, method of formation, coloration, and other characteristics—constitute a soil series. Some of the soils of the area are of rather local occurrence and of questionable relationship and are given local names.

A distinction is made between the residual soils, according as they are derived from shales and sandstone or from limestone. The shale and sandstone have entered more largely into the soils of the county than the limestone and have given rise to soils of three series

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and to one miscellaneous type more or less closely related thereto. The Boone silt loam and the Boone fine sandy loam are characterized by very light gray surface soils, the Bates silt loam and Bates loam by gray surface soils, and the Summit silt loam and Summit clay by dark-gray or nearly black surface soils. The distinguishing feature of the Oswego silt loam is the presence of a so-called hardpan in the subsoil. The limestone gives rise to the Crawford silt loam previously mapped in Kansas.

The colluvial class of soils is represented by the Sedgwick black clay loam, which in its material is closely related to the Summit soils.

The bottom land or alluvial soils are related to each other in the source of their material and the manner of their formation, but differ in respect to color, position, and elevation in the bottoms.

The Osage silt loam occupies the creek bottoms and higher elevations along the larger streams, while the Osage clay occupies the depression in the wider bottoms and belongs to a series characterized by the dark color of the soils. Very little sandy material or loam was found in these alluvial deposits and the loam type was not recognized, though certain phases of the Osage silt loam approximated a soil of lighter texture. There are along some of the streams areas locally called second bottom. There is every reason to believe, however, that the materials here are not of alluvial origin and the soils are therefore grouped with the upland types. Along some of the smaller streams there exist a few areas of true terrace deposits, but these were so limited that they could not be shown in a map of the scale used.

The following table gives the name and extent of each of the types of soil found in Bates County:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Oswego silt loam	200,192	36.1	Crawford silt loam	11,072	2.0
Summit silt loam	152,512	27.5	Sedgwick black clay loam	2,496	.5
Osage silt loam	71,808	12.9	Rough stony land	2,240	.4
Bates silt loam	50,880	9.3	Boone silt loam	1,984	.3
Osage clay	23,232	4.2	Boone fine sandy loam	960	.2
Bates loam	21,888	3.9			
Summit clay	14,976	2.7	Total	554,240	.....

OSWEGO SILT LOAM.

The characteristics by which the Oswego silt loam are easily distinguished from the other types of the area are its prairie vegetation, gray color, ashy feel, level surface, and the sharp line of demarcation between soil and subsoil. The surface soil consists of 8 to 10 inches of dark-gray, rather loose structured silt loam, which when wet becomes a very dark gray or almost black but when dry is very much

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lighter colored. It is locally known as "white ashy land." The subsurface soil from 10 to 18 inches is always lighter colored, contains very much less organic matter, and has a slightly higher clay content than the surface soil and as a consequence tends to clod considerably. It also becomes quite compact and hard when dry. Immediately below this material lies the heavy, compact, somewhat tenacious silty clay subsoil which extends to a depth of 36 inches, where it becomes friable and crumbly, decreasing in clay content. From 18 to 28 inches this material is usually much darker than the overlying soil, frequently being almost black, but rapidly changes to a grayish yellow with a faint greenish tinge.

This soil type as mapped in this survey consists of two distinct phases that are universally recognized not only by the student of soils but by the farmers who occupy it. The difference between the two phases is one of structure rather than texture, yet it is one of great importance in the agricultural utilization of the soil. One phase is the flat-land phase and the other the rolling-land phase. In both the surface soil is a gray silt, and in both this is underlain by a darker, tougher, more clayey subsurface. In the flat-land phase, however, the boundary between the surface and subsurface is a very sharp one; in the other it is more indefinite. In the former the subsurface is a hard, tough, dark, brownish-clay with some red mottlings. In the latter it is a dark, brownish-gray silty clay, usually without the red mottling and usually neither so hard nor so tough as the former. In the former the subsoil is a yellowish-gray to bluish-gray silty clay, with a yellowish to brownish mottling, but considerably less tough than the subsurface. In the latter the subsoil is a yellowish-gray silty clay much more nearly uniform in color than that of the former phase.

The rolling-land phase has much better surface drainage than the other and its underground drainage is also better. Its color also is usually somewhat darker.

The rolling-land phase constitutes much the larger area of this type in the county. Practically all of the type in the southwestern corner of the county belongs in it and all the eastern part of the great area of this soil that lies west and northwest of Butler.

The main flat-land areas are in a belt running northeast and southwest through Adrian, along the foot of the third terrace, in the southeastern corner of the county.

The farmers will admit that the flat-land phase is "hardpan" land, but they will not admit that the rolling-land phase can be correctly designated by that term.

The Oswego silt loam is the most extensive soil type in Bates County, occurring in every township. It is the predominating type in the northwestern two-thirds, where it occupies many entire sections. It also occurs extensively in the southwestern and south-

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eastern townships. The area of its least development lies from Pleasant Gap northward to the county line.

The type is intimately associated with level or undulating topography and is always limited by a rolling surface whether that surface lies above or below the general level of a given area. It occupies the wider divides, gentle slopes, and the rather low-lying, so-called "second bottoms" along the rivers. The last-named position is the lowest level at which the type is developed and includes elevations in the uplands from below 750 feet to something over 800 feet. Its highest elevation reaches more than 1,000 feet in the northwest corner, and the remainder of the type from a little below 850 feet to more than 900 feet above sea level.

Though perfectly flat areas are not frequent and there is apparently enough fall to afford good surface drainage, the damage done to crops by excess of moisture is very great. The present season was a severe one in this respect, and much of the corn was abandoned as worthless early in the season. The heavy subsoil is to some extent accountable for this, as it greatly retards the downward movement of drainage waters. This trouble can be largely relieved by tile drains, which, though results might not be immediate, would ultimately break up the close structure of this material naturally loose and crumbly when exposed to the air. Narrow, open ditches or even furrows would be effective in draining many of the small depressions in which corn is a failure in wet seasons. There is sufficient fall in almost every case for the proper construction of drainage systems. In the few instances where tile drains have been installed they have given good results.

The formation of the Oswego silt loam is not clearly understood in its details. It is evidently connected with shale formations, as it is underlain at greater depth by silt shale rock and it would seem that the subsoil at least was derived therefrom. But the formation of the 18 inches of light silt soil can hardly be explained by residual processes alone, because of the great difference between it and the underlying subsoil and the sharp line of demarcation between the two. The dark color in the upper portion of the subsoil suggests that it may be due to an accumulation of organic matter at a time when it was the surface soil and that the overlying material is a later deposit. But the differences in elevations at which the type is found would preclude the theory of water deposit and the material is somewhat different from that heretofore recognized as loess or wind blown. It is possible to account for it by translocation or gradual movement of the finer particles from the surface to the subsoil, though the sudden change in material almost refutes that theory. That the subsoil is largely residual material from the underlying shale seems fairly certain, but that there has been some other process involved in the

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surface and subsurface soil is also plain, but what it is is still a matter of conjecture.

The original vegetation of this type was prairie grass, which grew very rank. Timber growth was probably prevented by prairie fires. All the general crops of the area are grown extensively on this soil. Corn is the leading crop, and more white corn is grown than yellow, it being the general impression that white corn will yield better than yellow on the "thinner" soils. The corn crop responds remarkably well to thorough cultivation, and the remarks regarding cultivation and planting of corn in the chapter on agriculture apply particularly to this type.

Oats yield from 10 to 40 bushels, flax from 6 to 10 bushels, broom corn about one-fourth ton, and hay about 1 ton to the acre. Clover seed usually yields about three-fourths bushel to the acre, though as high as 5 bushels were reported. Cowpeas are grown to some extent, but not nearly so generally as they should be. Alfalfa was seen growing on this type. The roots seem to penetrate the heavy subsoil, and this crop should succeed where conditions are made as favorable as possible.

Besides drainage, the two main factors controlling crop production on this soil are the maintenance of a supply of organic matter and the conservation of moisture. When the prairie sod was first broken an abundance of organic matter had accumulated from the roots of the prairie grass. The soil then was loose and open, but through many years of constant cultivation the original supply of humus has been largely depleted, and, as a consequence, the soil particles have become more or less compact, thus indicating rapid capillarity and the loss of soil moisture at a time when it is most needed. The deficiency of humus is also largely responsible for the cold, soggy condition sometimes found in the type. In other ways, the loss of humus has been detrimental to crop production, and the addition of vegetable matter will do much toward improving this type. The humus content can best be increased by applying stable manure or by plowing under cowpeas, clover, manure, or any green manuring crop. The deeper this can be incorporated in the white subsurface soil the better will be the results. Because of its effect upon the soil drainage, the heavy subsoil is usually regarded as a detriment, but it may really be advantageous in that it prevents leaching. During the progress of this survey an examination was made of a field which had been fallowed and a dust mulch constantly maintained, and during the driest part of the summer, when the crops were suffering for moisture, it was found that the soil and subsoil were so moist that the change from subsurface to subsoil was scarcely discernable. In this connection it is strongly recommended that the cultivation of corn be continued with one-horse shallow cultivators beyond the time when it is usually "laid by" and

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well into the season, thereby conserving moisture for the crop at a time when it needs much and usually gets little.

Very little fertilizer except barnyard manure is used on this type. It is said that applications of manure are effective for a period of five to seven years. Commercial fertilizer analyzing 2–10–2 applied to corn gives an increase yield per acre of 7 bushels.

The average results of mechanical analyses of samples of the Oswego silt loam are given in the following table:

Mechanical analyses of Oswego silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
20004, 20010...	Soil.....	0.1	1.2	0.9	1.2	1.3	77.8	17.4
20005, 20011...	Subsoil.....	.1	1.7	1.5	1.7	2.4	74.1	18.8
20006, 20012...	Lower subsoil...	.0	.8	.7	1.3	2.5	55.4	39.1

SUMMIT SILT LOAM.

The Summit silt loam is one of the most important soil types of the area. The surface soil is uniformly a very dark gray or black rather heavy silt loam which may vary in depth from 6 to 20 inches, though averaging about 10 inches deep. A distinguishing characteristic of this material is its constant tendency to granulate or break up into small aggregates, with the result that it does not run together, pack, bake, or crack. The subsoil is quite variable. Immediately below the surface soil, usually at about 10 inches, the material becomes lighter colored and slightly heavier, though maintaining the granular structure to about 20 inches, at which point granulation usually disappears and the clay content increases rapidly with depth, the deeper portion being a yellowish or greenish tinged, gray silty clay, or clay loam very similar to the deep subsoil of the Oswego silt loam. An extensive phase of the subsoil occurs in which the material is not heavier than a clay loam and the color is yellowish-gray mottled with reddish brown or brownish red. The granular structure is maintained to some extent in this phase throughout the soil profile. Outcrops of limestone rock are frequently found and small, rounded chert gravel are locally disseminated through the subsoil. Small iron concretions also frequently occur and are largely responsible for the mottled condition of the phase.

Though there is no township in which some of this type does not occur, the most extensive areas lie to the south and east of Butler and in the northeast part of the county.

The topography is generally rolling, the type occupying narrow ridges and slopes and higher mounds. It occasionally continues over

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rather flat areas lying between ridges, and flat areas also occur on the type of the higher elevations. The prevailing topography insures fairly thorough natural drainage, but the character of the soil is such that water does not penetrate it as rapidly as is often desired, and in many places tile drainage would be very beneficial, not only in removing surplus water, but in aerating the soil.

The greater part of the type occurs in the breaks of streams, where the elevation is from 850 to 900 feet or below that of the greater part of the Oswego silt loam, though the areas in the northwest corner and around the mounds lie above the greater part of the latter type, the elevations there being from 950 to 1,000 feet.

Locally, the Summit silt loam is known as "black limestone land," implying that it is derived from limestone rock, which, however, is not the case. It is a residual soil formed from strata of shale, above and below which occur thin strata of limestone which frequently outcrop and give the type its local name. The limestone has probably contributed some material to the soil, but the proportion of such material is relatively small. The uniformly dark or black color of the soil is probably due more or less to the thin layer of black shale which immediately underlies the limestone. In low spots on some of the more level areas of this type a white crust was seen closely resembling alkali, but these areas were small and of little consequence.

Like the Oswego silt loam, almost all of the Summit silt loam was originally prairie and when first broken up was very loose and friable. Some of the type, especially along streams, supports a scant growth of persimmon, pecan, and oak.

This is the best upland corn soil in the county and is usually so regarded. The mellow surface, good drainage, and heavy subsoil fit it especially for this crop. By many it is considered the best wheat soil of the area also, but if the Oswego silt loam is properly handled it will probably outrank this soil in the quality and yield of wheat.

That portion of the type originally timbered produces good tobacco. Just what influence the timber has had is not understood, but the fact remains that where timber has stood the soil will produce good tobacco, while the prairie will not.

Some alfalfa was seen growing well on this type, and there seems to be no reason why it should not succeed as a regular crop.

Corn yields from 35 to 40 bushels, wheat 15 to 20 bushels, hay 1 ton, and flax 6 to 8 bushels per acre.

Fertilizer is not extensively used, but applications of 150 pounds of a 10–2–2 grade give an increase of about 5 bushels of wheat, indicating that the soil will respond to applications of phosphorus. Fall plowing of this type is considered essential for best results.

The Summit silt loam is nearly all under cultivation and is regarded as the strongest soil of the area for general crops. It is valued at $50 to $80 an acre.

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The following table gives the average results of mechanical analyses of fine-earth samples of this soil:

Mechanical analyses of Summit silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
20015, 20017	Soil	0.2	1.3	0.9	1.9	3.7	61.5	30.5
20016, 20018	Subsoil	.5	1.9	1.0	2.8	4.4	48.5	40.7

BATES SILT LOAM.

The soil of the Bates silt loam is a loose, mellow silt loam of a dark-gray color to a depth of 8 to 10 inches, at which depth it becomes a yellowish-gray, mellow silt loam. When wet this material has a peculiar mushy feel, but when puddled and allowed to dry it becomes very hard and compact. The deeper portion of the surface soil, which apparently contains less organic matter than the overlying material, has a tendency to run together. There is frequently a rapid gradation between the subsurface soil and the subsoil which is found at a depth of 20 to 36 inches. It is a yellow and red mottled clay loam which becomes slightly heavier with depth, and is seldom plastic or sticky though frequently somewhat tenacious. When dry it becomes quite hard and impenetrable. The heaviest phase approaches closely the mottled subsoil phase of the Summit silt loam and in places where a part of the surface soil has been removed by erosion the land is likely to be confused with the Boone silt loam. The largest area of Bates silt loam lies in the vicinity of Hudson, in the southeastern part of the county. It occurs, however, in all parts of the county associated with the Oswego silt loam. It lies both immediately above and below that type, particularly in its lowest lying areas, and is separated from it by rather distinct boundaries. It is also frequently associated with the Bates loam, areas too small to be shown on the map being quite commonly developed in that type.

Areas of this soil form hill slopes, narrow ridges, and low elevations, along the breaks and streams, and in low places in the main body of the Oswego silt loam. While its topography for the most part favors thorough drainage, along the boundaries with the Oswego silt loam it is very frequently wet and soggy, owing to the accumulation of seepage waters which flow out of the latter soil along the surface of the compacted subsoil. The same conditions are found where water is obstructed in its downward course by shale and sandstone strata in the subsoil of the Bates loam. So far but little effort has been made to tile drain these seepy areas, though this would be entirely feasible.

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The Bates silt loam is a residual soil formed by the disintegration of soft shale which immediately underlies it. The material is closely allied to the Oswego silt loam, but being modified by drainage conditions has developed its characteristic differences. Much of this soil was originally timbered, though some was also in prairie. Most of it has been cleared, but along the streams some hickory, sycamore, and oak still remain.

The ease with which the soil can be cultivated, its rather heavy subsoil, and ability to hold fertilizers make it a popular and valuable soil for general farming. Corn yields on an average about 30 bushels, wheat 12 to 15 bushels, and flax 8 bushels to the acre. Much of the type is utilized for the production of hay, partly because it is likely to gully and wash under cultivation and partly because the areas affected by seepage can best be used for this purpose. Hay yields from 1 to 1½ tons to the acre.

On that part of the type originally timbered a very good quality to tobacco is grown when heavily manured. The soil is often deficient in humus, which needs to be supplied in order to get the best results.

The following table gives the results of mechanical analyses of soil and subsoil of the Bates silt loam:

Mechanical analyses of Bates silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19989	Soil	0.0	1.2	0.9	6.2	9.7	67.2	14.6
19990	Subsoil	.6	1.1	.9	5.9	12.8	57.3	21.3
19991	Lower subsoil	1.5	1.6	.6	4.0	5.1	50.2	36.6

CRAWFORD SILT LOAM.

The Crawford silt loam, locally known as "red land," consists of about 10 inches of dark brownish gray to dark-brown silt loam, underlain by a rather dark brownish-red subsoil, which becomes heavier and more intense in color with depth until at 36 inches it is a nearly red, somewhat plastic and sticky clay. Except for the slight brownish cast the soil closely resembles that of the Summit silt loam, being granular and rather mellow, which makes it easily tilled. It is usually well supplied with organic matter.

The subsoil is underlain with limestone rock which is frequently struck in boring at from 24 to 36 inches. The type is frequently found in isolated areas within bodies of the Summit silt loam, particularly in the region north of Pleasant Gap and in the northwest part of the county.

Stratigraphically the most of the type is developed immediately above the shale which gives rise to the Summit silt loam and below

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the shale from which the Bates loam and Oswego silt loam are derived. It is found on gentle slopes and narrow ridges and has a level to undulating topography and good natural drainage. The subsoil is no doubt true limestone material derived from the underlying rock, but the soil represents a mixture of shale material washed from, or the remnants of, the Summit silt loam or Oswego silt loam, with material of limestone origin.

The type is now practically all under cultivation or in pasture or mowing. It has all the essential characteristics of a corn soil and is considered by many as the best corn-producing soil of the area. The yields are about the same as on the Summit silt loam. Corn yields 35 to 40 bushels, wheat 12 to 18 bushels, oats 15 to 20 bushels, and hay 1 to 1½ tons to the acre. So far as known no commercial fertilizers are used on this soil.

There is an eroded phase of the type occurring in small areas within the Summit silt loam. Conditions favoring the formation of this phase exist only on sharp narrow ridges or the higher mounds. The soil is a mellow, somewhat granular silt loam, of a reddish-brown to red color, with a depth of about 8 inches. Limestone rock is found at depths ranging from 12 to 48 inches and limestone fragments occur frequently over the surface and in both soil and subsoil. This phase of the Crawford silt loam, excepting the more stony parts, is adapted to the same crops as grown on the main areas of the type.

The following table gives the average results of mechanical analyses of soil and subsoil of the Crawford silt loam:

Mechanical analyses of Crawford silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19994, 19996, 19998..	Soil.....	0.1	1.2	0.5	1.2	3.0	72.4	21.2
19995, 19997, 19999..	Subsoil....	.3	1.0	1.2	1.8	2.8	54.6	37.9

BATES LOAM.

The Bates loam is more or less variable in its texture and color as well as in depth. The typical soil consists of about 8 inches of loose structured light loam, which is brown when moist, but becomes a light gray when thoroughly dry, though often the color is a very dark gray to almost black. The texture is often very fine, closely resembling the Bates silt loam and also the Boone fine sandy loam, and areas too small to map of both these types occur within the boundaries of the Bates loam. The soil is usually mellow and easily tilled, but after heavy rains there is a tendency to form a surface crust which, however, is easily broken up.

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The subsoil is usually a solid buff color, though areas with mottled red and yellow occur. The texture is usually a fine sandy clay loam or clayey loam, quite gritty from its sand content and yet made sticky by clay. The percentage of silt is relatively low. Arenaceous shale resembling in color the subsoil is encountered at depths ranging from 18 to 48 inches. This material is soft and appears very sandy, but on crumbling and rolling between the fingers becomes very fine.

The largest areas of the Bates loam lie east of Butler around Sprague and in the vicinity of Foster. It is also extensively developed in the northeast corner. It usually occupies ridges and knolls and in the rougher sections occurs as a distinct terrace. It is found to a slight extent on slopes and in flat areas near the base of hills.

Stratigraphically in the hilly regions it lies immediately above the limestone soil if developed, otherwise, it is found above the Summit clay. It is usually the highest soil, though areas of Bates silt loam and Oswego silt loam sometimes lie at a higher level. Because of its topographic position and texture the natural drainage is nearly everywhere good, and on this account it outyields the other types in wet years.

The Bates loam is derived from the disintegration of arenaceous shale and sandstone strata in the main shale formation, and the variations in the type are largely due to variations in the contributing material augmented by washing and drainage.

Originally areas of this soil formed a part of the prairie. It is now devoted to general farm crops and market gardening. Corn yields from 30 to 35 bushels, wheat 10 to 15 bushels, flax 6 to 8 bushels, and oats 10 to 20 bushels per acre. Considerable trucking is done, and the soil is admirably adapted to that purpose. Watermelons are produced at considerable profit.

The supply of organic matter over most of the type is deficient. The supply of humus and organic matter should be incorporated with the soil as rapidly as possible. This will increase crop production by conserving moisture, an important matter, as the crops are likely to be injured by drought. The use of commercial fertilizers, especially in the growing of truck, has been found beneficial.

The soil is usually regarded as acid, and quite a sharp reaction was obtained in both soil and subsoil with litmus paper, indicating that rather heavy applications of lime should be made.

The following table gives the results of mechanical analyses of the soil and subsoil of the Bates loam:

Mechanical analyses of Bates loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
20000	Soil	0.0	0.3	1.0	41.2	9.3	32.3	15.8
20001	Subsoil	.0	.5	1.0	39.0	8.3	26.2	24.8

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BOONE FINE SANDY LOAM.

The Boone fine sandy loam consists of about 8 inches of gray, loose structured, and rather incoherent fine sandy loam, underlain after a rapid gradation by a clayey loam or fine sandy clay loam the upper portion of which is mottled gray and buff rapidly changing to a red with depth. Sandstone or arenaceous shale rock underlies the subsoil at from 10 to 30 inches. Mica flakes and some sandstone and shale fragments occur in both soil and subsoil, and the latter occasionally on the surface. Owing to its friable porous texture this soil can be worked under a wide range of moisture conditions. Only a limited area of this type of soil occurs in Bates County. The largest area is found south of Butler and west of Peru. A few areas too small to be indicated on the soil map are included with the Bates loam.

The type occupies narrow ridges and rather abrupt slopes and consequently has very thorough drainage. It is derived from a micaceous, arenaceous shale and sandstone which are quite soft and easily crumbled. On the slopes, which are usually quite sandy, washing has probably removed some of the finer material and left the sand.

The greater part of the type is under cultivation. Corn yields about 20 bushels, wheat 10 bushels, and oats 10 bushels to the acre. Some truck crops are grown, and the soil is better adapted to such crops than to general farming.

The quantity of organic matter is even less in this soil than in the Bates loam and must be greatly increased to secure the best results. In order to grow clover it will be necessary to give the fields heavy applications of lime to correct acidity, as litmus-paper tests showed the soil to be decidedly acid.

The results of mechanical analyses of fine-earth samples of the Boone fine sandy loam are given in the following table:

Mechanical analyses of Boone fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
20002	Soil	0.0	0.5	2.9	48.6	11.9	28.7	7.3
20003	Subsoil	.0	.3	1.7	41.1	9.1	22.3	25.2

SUMMIT CLAY.

The soil of the Summit clay consists of from 5 to 8 inches of heavy adhesive black silty clay or clay. In boring large lumps of the soil are pulled up with the auger. The subsoil to a depth of 36 inches is a puttylike, plastic clay, of a yellowish-gray or greenish

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color. Limestone and chert fragments are strewn over the surface and small lime concretions are numerous in the subsoil. Although the soil is naturally very plastic and tenacious, when plowed and exposed to the action of frost it breaks down into a crumbly mellow condition. The areas of the Summit clay are found in the rougher parts of the county southeast of Peru and in the vicinity of Pleasant Gap. The largest areas are in the northwestern part of the county. The type occupies steep slopes, ravines, and very narrow stony ridges. Most of the areas mapped Rough stony land contain much of this type but with more broken topography.

The areas lie just above the Summit silt loam and below the Crawford silt loam, or if the slope is not sufficient for either of those to be developed the Bates loam lies above it. The drainage is usually excessive, though there is apparently no tendency to wash or gully and the soil seems to withstand drought well.

The type is of residual origin. The soil has been derived from a stratum of clay shale which underlies the limestone and as outcrops of the latter are frequent just above it, it is commonly called "heavy black limestone land." Owing to the fact that the shale stratum is very thin the areas of this type are limited. The black color of the soil is due at least in part to the color of parent rock. The limestone and chert fragments on the surface are the remnants of the limestone stratum which at one time rested upon the shale or they have been derived from the outcrops which usually occur on the slopes just above the Summit clay areas. Cultivation of this type is largely confined to the less broken areas, where the soil is more nearly a clay loam. The rougher topography and stony character of the more typical clay areas prohibit farming operations. Most of the area is forested with oak and persimmon, much of which could be profitably utilized for the production of fence posts. Some of it could also be used as pasture; clover and even alfalfa should succeed well, as the soil is high in lime and the drainage is excellent. On areas suitable for tillage corn and wheat yield well, though no definite yields can be given.

The following table gives the results of mechanical analyses of fine-earth samples of the soil and subsoil:

Mechanical analyses of Summit clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
20019	Soil	0.2	1.7	1.3	4.9	4.6	50.9	36.6
20020	Subsoil	.9	2.7	1.4	2.8	2.2	43.7	46.2

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OSAGE CLAY.

The Osage clay consists of about 18 inches of black heavy silty clay or clay, which grades into a bluish-drab clay subsoil. There is frequently but little change from the soil to the subsoil, both being very plastic, sticky, and tenacious when wet. When dry the surface becomes quite granular and mellow. In the vicinity of old lake beds the subsoil is slightly mottled with brown and is not quite so heavy as over the greater part of the type.

This is a bottom-land soil found in the wide bottoms of the Osage River, in the narrow bottoms of the Grand River along the northeast boundary of the county, and in two small areas in the Miami Creek bottoms. It occupies the lowest levels in the county and the topography is flat. The areas are usually lower near the bluffs and higher near the streams, from which they are separated by a narrow band of Osage silt loam.

Practically all of this type is at present subject to deep and prolonged overflow. A drainage district has been organized for the purpose of reclaiming a part of the type. A large drainage ditch is being cut through the Osage bottoms and it is expected that this ditch will render several thousand acres of the Osage clay suitable for cultivation. The soil has been formed by the deposition of the finer sediments carried by the several streams along which it is found. Its black color is due to the accumulation of relatively large quantities of decaying vegetable remains, mostly the stems and roots of coarse grasses.

The greater part of the Osage clay is now covered with a rank growth of prairie grass, which is usually cut. Some parts support forests of water-loving oaks and pecan. In the timbered areas the soil is somewhat looser in structure, and the surface is usually gullied. Such areas if cleared would be difficult to cultivate.

Even if the drainage ditch under construction prevents overflow of the lands along the Osage it will be necessary to install tile drains in order to make the reclamation complete. Underdrainage, although expensive on account of the need of running the drains at close intervals, is particularly advantageous in having the close structural characteristic of the Osage clay, as it tends to make the soil more open and friable.

This is typical corn soil. Though not much corn has yet been produced on it, with thorough drainage yields of 75 to 100 bushels per acre may be expected. Unless it is found that wheat makes too rank a growth the land should also produce large yields of that grain. It will probably be difficult to make it suitable for alfalfa. Some broom corn is produced on the type but it is too coarse to be of first quality.

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Fall plowing, which allows the soil to weather and crumble during the winter, will be found the best practice. In spots which are very heavy and difficult to work an application of lime, which flocculates the particles, will aid in securing good tilth.

The results of mechanical analyses of soil and subsoil of the Osage clay are given in the following table:

Mechanical analyses of Osage clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
20021	Soil	0.1	1.1	0.6	2.7	1.8	56.5	37.3
20022	Subsoil	.0	2.1	1.3	9.1	3.0	37.8	46.9

OSAGE SILT LOAM.

The Osage silt loam is the most variable type of soil in the county. The surface soil is usually a light-gray, slightly compact, silt loam ranging in depth from 8 to 24 inches. This material in most instances grades into a heavy silt loam subsoil of somewhat darker color, though it may be underlain by a drab clay loam or in some cases by a black clay. The areas of any one phase are so small that separation seemed impossible, and characteristics other than being a light-colored silt loam on the surface were ignored in mapping. Some small spots of loam were found, but their total area was so small that a separation was not made.

The type occurs in all the stream bottoms and is broken in the wider bottoms only by the Osage clay. Along the Grand and Osage rivers it occupies the slightly elevated land next to the stream channels. It is largely alluvial material deposited in times of overflow, but some areas adjoining the upland probably contain material which has been washed down over the Osage clay and now forms the subsoil. Most of the type is subject to overflow and for this reason is largely left in grass or forest, very little being under cultivation. If the drainage ditch along the Osage prevents overflow, this will be a valuable soil for practically all crops. Alfalfa should do particularly well. Some of the type would be benefited by tile drainage and by incorporating vegetable matter in the soil.

The following table gives the results of mechanical analyses of the soil and subsoil of the Osage silt loam:

Mechanical analyses of Osage silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
20023	Soil	0.2	0.9	0.8	1.0	1.1	66.9	29.2
20024	Subsoil	.0	1.0	.7	1.0	2.9	63.9	30.2

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SEDGWICK BLACK CLAY LOAM.

The Sedgwick black clay loam consists of from 12 to 18 inches of somewhat plastic though slightly granular clay loam or silty clay, which grades into a gray, plastic, and sticky silty clay or clay subsoil. This material closely resembles the deep subsoil of the Oswego silt loam and also somewhat the subsoil of the Summit clay. Frequently a drab color is also developed in the upper subsoil.

This is relatively an unimportant type, occurring principally at the foot of the highlands in the northwest part of the county. The surface soil is largely colluvial material which has been washed from the adjoining higher-lying Summit clay or silt loam areas. The subsoil is probably residual material from shale.

The type occupies rather flat depressions, and needs drainage. It is largely used for pasture and mowings, though if drained, it would be an excellent corn soil. Possibly it would prove too strong for wheat. As the areas are not large, sufficient fall exists for the proper installation of tile drains.

The results of mechanical analyses of soil and subsoil of this type are given in the following table:

Mechanical analyses of Sedgwick black clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
20013	Soil	0.0	1.0	0.5	2.2	9.9	57.9	28.3
20014	Subsoil	.2	1.1	.6	1.8	8.5	61.1	26.8

BOONE SILT LOAM.

The soil of the Boone silt loam consists of 6 to 10 inches of light-gray to almost white, floury, and ashy silt loam. The subsoil to a depth of 36 inches is a rather compact yellow silt loam or light clay loam. The material of the soil and upper subsoil in some areas closely resembles loess.

Isolated areas of this type of soil are found throughout the county. They occupy rather low-lying flats and slopes usually broken by short water courses and in some places form narrow strips along streams between the bottom land and the Oswego silt loam or Bates silt loam. The soil is evidently composed of the same material as these types, though it has acquired distinct characteristics through the modification of these materials by different drainage conditions. The presence of timber growth, principally oak and hickory, has doubtless had some influence in the formation of the type.

But little of the type is under cultivation and the yields are low. The incorporation of organic matter would greatly improve this soil. No sample was taken for mechanical analysis.

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ROUGH STONY LAND.

In some parts of the county there are areas which are too rough and stony for cultivation. These have been indicated on the map as Rough stony land. They are usually associated with the Summit clay. They afford some scant pasture, but their chief use will be the production of timber.

SUMMARY.

Bates County is situated in southwest Missouri. It has an area of 554,240 acres or 866 square miles.

The surface features have been developed by erosion and influenced by the relative hardness of the limestone, shale, and sandstone which form the country rock. In general, the topography is undulating to gently rolling, with rougher areas in the limestone region along the streams.

The county is drained almost entirely by the Osage River and its tributaries, though the Grand River drains the northeastern part.

The first settlement was a mission established near Papinsville in 1821. The earlier settlers came from Kentucky, Tennessee, and Virginia, but in late years the immigration has come from the north and immediate east.

The present population is largely rural and well distributed. Rich Hill is the largest town, Butler is the next in size, and many other small towns are scattered over the county.

There are about 100 miles of railroad in the county. The Missouri, Kansas and Texas Railway crosses the southeast corner; the Missouri Pacific and the Kansas City Southern run parallel north and south across the county in the middle and near the western boundary, respectively; the interstate branch of the Missouri Pacific runs west from Butler into Kansas, and a branch of the Missouri, Kansas and Texas runs into Rich Hill from Kansas. Kansas City, 75 miles north, is the principal market, though St. Louis is also easily reached.

The climate is distinctly humid and adapted to all general farm crops.

The raising, fattening, and marketing of live stock is the most important industry.

A large number of crops are grown, which, named somewhat in the order of their importance, are as follows: Corn, wheat, timothy and clover, oats, flax, sorghum, Kafir corn, millet, cowpeas, tobacco, and alfalfa. Corn is the main crop and is almost all fed to live stock. Wheat is a money crop and is sold largely at local mills. Hay is consumed mostly on the farm. Oats have proved more or less a failure in recent years, and the selection of a winter variety suited to the region is suggested. Flax constitutes a minor money crop and an excellent nurse crop for grass. Kafir corn is grown as a supple-

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mentary forage crop. Cowpeas are becoming more popular. White burley tobacco is grown in a limited way and there is some promise of its more extensive cultivation. Alfalfa is in the experimental stage, but the results obtained indicate that it can be grown extensively. There is but one commercial orchard in the county, though most farmers produce fruit for home consumption.

The rotation practiced in a limited way consists of corn followed by corn, oats, wheat followed by wheat, and then timothy and clover for from two to four years. Cowpeas should be introduced in the rotation whenever possible, either as a catch crop or as a main crop.

The percentage of tenanted land is increasing, and from $2 to $3 an acre, or two-fifths to one-half of the crops produced is ordinary rent. Land sells at $25 to $60 an acre.

Twelve types of soil were mapped in the county. Most of these were residual, or derived from underlying rock formation. The others were alluvial soils, forming the bottoms along the streams.

The Oswego silt loam, locally known as "white ashy land," is the predominant type, and occupies level or undulating uplands. It is well adapted to wheat, oats, and hay. The type is deficient in organic matter, and the drainage should be improved.

The Summit silt loam, called "black limestone land," is not a limestone soil, but is derived from shale. It is a typical corn soil, and wheat also yields well. The Crawford silt loam is a reddish limestone soil with good drainage. It is an excellent corn soil.

The Bates loam and Boone fine sandy loam, locally called "sandy soils," are adapted to market gardening and are so used.

The Summit clay is a heavy black soil of relative small extent and is mostly timbered.

The Bates silt loam is a brownish-gray soil with a mottled subsoil. It occurs along slopes near streams and is a good grass and general farming soil.

The Sedgewick black clay loam would be a corn soil if well drained.

The Boone silt loam is of relatively small importance, occurring as timbered land along streams.

The bottom land soils are the Osage clay and Osage silt loam. The former is a heavy black clay and, though a typical corn soil, its cultivation is largely prevented by adverse drainage conditions. The Osage silt loam is a higher-lying soil nearer the streams and is cultivated to some extent. It is recognized as producing corn of excellent feeding quality. A drainage project to drain the bottoms of the Osage River is now nearly completed, and in case it is effective about 40,000 acres of these excellent corn soils can be cultivated.

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SOIL SURVEY OF RICHLAND COUNTY, NORTH DAKOTA.

By FRANK BENNETT, E. L. WORTHEN, REX E. WILLARD, and E. B. WATSON.

DESCRIPTION OF THE AREA.

Richland County, N. Dak., is located in the extreme southeastern corner of the State. It is bounded on the north by Cass County, on the west by Ransom and Sargent counties, on the south by South Dakota, and on the east by Minnesota. The greater portion of the county lies north of the forty-sixth parallel north latitude, and east of the forty-eighth meridian west longitude, and has an area of 929,920 acres, or 1,453 square miles.

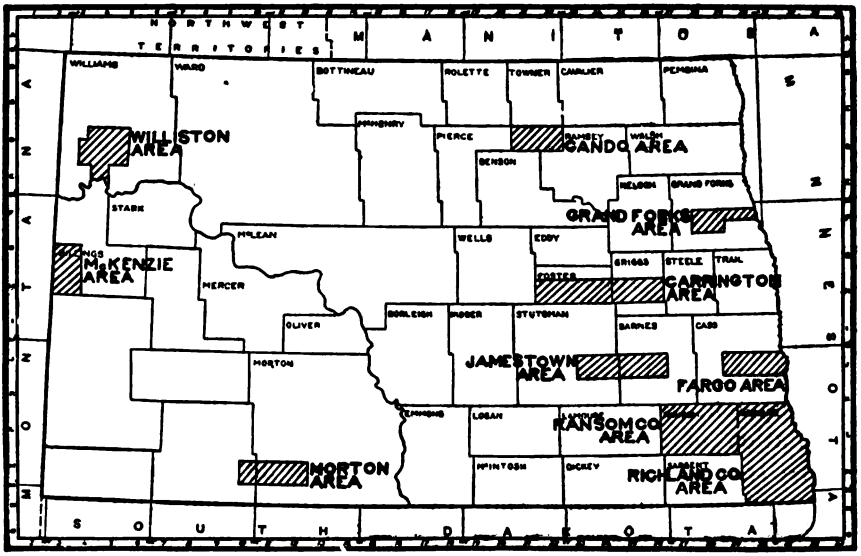

FIG. 32.—Sketch map showing location of the Richland County area, North Dakota.

There are three distinct topographic divisions in Richland County. One consists of the country formed by the deposition of glacial till in the form of moraines, another is the region occupied by lacustrine deposits of Lake Agassiz, and the third is the territory comprising the delta deposits of the Sheyenne River in the old lake bed. The country formed by the glacial till in the southwestern part of the county is rolling to roughly hilly, with intervening sloughs and depressions. Characteristic bowlders and gravel are found scattered

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over the surface. The lacustrine deposits occupy the eastern portion of the area and are level to undulating, while that formed by the delta is rolling to hilly.

The Sheyenne, Red, and Wild Rice rivers are the most important streams of the area. The Sheyenne River enters the northwestern corner of the county near Power and flows in a northeasterly direction, leaving the county near the center of the northern boundary line. Short and deep tributaries have cut back from the river and drain the county for a few miles on each side. The Red River, with its tributary, the Bois de Sioux, forming the eastern boundary line of the county, drains a portion of the area. There are a few small coulées[a] tributary to this stream. The Wild Rice River enters the county in Wyndmere Township, about 3½ miles south of the Northern Pacific Railway, and flows in a southeasterly direction toward Great Bend, where it turns and flows northward. From a point 5 miles west of Wahpeton its course is almost parallel to that of the Red River for a distance of about 25 miles to the northern boundary of the county. A few coulées are tributary to the Wild Rice River, the largest being Antelope Creek.

The population of the county is 19,379. It includes many Germans, Norwegians, and Swedes. In the vicinity of Great Bend, and in the northeastern portion of the county, many prosperous farmers are found. At the time this section was opened for settlement many settlers came from Iowa and other older States. The eastern and southern portions of the county are the most thickly populated, the western portion being quite sparsely settled. A few quarter sections among the sand dunes are still open for entry. When the western and northwestern portions have a proper drainage system there should be an influx of population, as much of the now uncultivated land is capable of producing good crops.

Wahpeton, the county seat and largest town of the county, has a population of about 3,000. Hankinson and Lidgerwood, located in the southern part of the county, are next in population, while Abercrombie, Fairmount, and Wyndmere are the more prosperous of the smaller towns.

The county is crossed by several railways, which furnish good transportation facilities. One of the main lines of the Great Northern from St. Paul to the West passes through Wahpeton, and thence northwest. The main line of the Minneapolis, St. Paul and Sault Ste. Marie enters the county at Fairmount and passes through Hankinson and Wyndmere northwest into Ransom County. A branch of the Great Northern from Tintah Junction, Minn., to Aberdeen,

[a] The word "coulée" is used in the local sense.

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S. Dak., crosses the southern portion of the county near Fairmount and passes through Hankinson and Lidgerwood. The branch of the Chicago, Milwaukee and St. Paul Railway from Ortonville, Minn., to Fargo, N. Dak., crosses the eastern part of the county. Fairmount, Wahpeton, and Abercrombie are the principal towns located on this line. A branch of the Northern Pacific crosses the county, Wahpeton, Mooreton, and Wyndmere being the chief towns on the line. Besides these lines, the Fargo and Southwestern, a branch of the Northern Pacific, passes just outside the northwestern border of the county, affording shipping points for farmers in this section.

The principal grain markets for the county are Minneapolis and Duluth, and frequent elevator stations are found on all the railroads. Each of the above-named towns in the area have three or more grain elevators, which are usually owned by the larger elevator companies. However, there are a few elevators owned by a company of farmers. Live stock is shipped to South St. Paul or Chicago.

The condition of the county roads varies according to the soil type over which they pass. Those along the Red River over the Fargo loam, Fargo clay loam, and Fargo clay are hard and smooth when dry, but when wet they are frequently almost impassable. In the spring they are usually in the worst condition, but in the fall, when the produce is hauled to market, they are generally good.

CLIMATE.

The climate of Richland County is typical of the northwest, the winters being long and cold and the summers short and cool. The summer nights are short and generally cool and the twilights long. The last killing frost in spring is about May 8 and the first in the fall about September 15, giving a growing season of about four months. Lighter frosts frequently occur between these dates, and frosts have been known to occur every month in the year in this region. Short periods of extremely cold weather occur in winter, when the mercury stands at —40° F., but as the atmosphere is dry the cold is not so severe as this low reading would indicate. The soil generally freezes in November to a depth of from 5 to 8 feet and remains frozen until spring, or about the 1st of April. From the 10th to the 20th of April plowing and cultivation are possible, even though the ground is frozen below.

Hailstorms occasionally damage the crops, but as these occur in small areas the damage is only local.

There are a few large windbreaks over the level prairie, but the northwest winds sometimes sweep across and do considerable damage.

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The following table shows the normal monthly and annual temperature and precipitation, the absolute maximum and minimum temperatures, and the total precipitation for the wettest and driest years:

Normal monthly, seasonal, and annual temperature and precipitation at Wahpeton.

Month.	Temperature.			Precipitation.			
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year.	Total amount for the wettest year.	Snow, average depth.
	°F.	°F.	°F.	Inches.	Inches.	Inches.	Inches.
December	15	54	−32	0.4	0.4	0.2	2.2
January	11	51	−30	.4	.4	.4	3.2
February	11	58	−44	.6	Trace.	1.2	4.9
Winter	12	.....	.....	1.4	.8	1.8	10.3
March	26	67	−33	1.2	1.9	1.8	8.2
April	46	92	− 2	2.5	3.4	5.1	1.1
May	58	98	−22	2.2	1.0	7.4	.0
Spring	43	.....	.....	5.9	6.3	14.3	9.3
June	67	101	27	3.4	2.6	5.8	.0
July	70	105	39	3.6	.2	4.8	.0
August	68	96	33	3.1	2.0	2.7	0
Summer	68	.....	.....	10.1	4.8	13.3	.0
September	59	98	19	1.7	.8	2.7	.0
October	47	88	13	1.8	2.3	.5	1.8
November	27	72	−25	.4	.7	.8	2.7
Fall	44	.....	.....	3.9	3.8	4.0	4.5
Year	42	105	−44	21.3	15.7	33.4	24.1

AGRICULTURE.

It was in the vicinity of Fort Abercrombie, where the town of Abercrombie is now situated, that the fertility of the famous Red River Valley was first revealed to the pioneers who settled on the prairies at a time when the presence of United States soldiers was necessary for protection from the Sioux. However, it was not until about 1880, when the Great Northern Railway entered the county, that real agriculture was begun. The first settlements were made along the Red and Wild Rice rivers. The timber along these streams was a protection in winter and was also convenient for building and for fuel.

Wheat and oats were the first crops grown, and later flax was found to give excellent results upon newly broken sod. This crop was grown very little in the early days owing to the low price, but in 1890 it became an important crop. At this time the price of flaxseed ranged from 60 to 85 cents a bushel. Since that time the price has gradually increased, and it has been as high as $1.50 a bushel.

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It was not until 1890 that barley came to be grown in considerable quantities. At the present time it is an important crop.

The broad prairies that surrounded the early settlers afforded large quantities of wild hay, and it was not until the country was well settled that it became necessary to grow the tame grasses. Timothy was found well adapted to the soil and has been quite extensively grown since the early nineties. In the last eight or ten years some clover has been grown, but it is not an important crop, as it does not withstand the severe winters.

Spelt has been grown to a considerable extent since the early nineties. It produces from 30 to 50 bushels per acre and occasionally more, and is chiefly used for feeding, being considered one of the surest crops for this purpose, as it never rusts and is not injured by frosts. Spelt is frequently mixed with oats and barley and ground for feed.

For the last eight or ten years several varieties of millet have been grown in small areas and are considered excellent crops for feeding purposes. Scarcely any of the crop is harvested for seed.

Corn has been grown for the last twelve years or more, the first good crop being grown about 1895. When first planted much difficulty was experienced in finding a variety that would mature before the early fall frosts. This has been overcome to a great extent by seed selection and acclimatization.

Wheat has always been the leading crop in the region. The next important crops are oats, barley, corn, and flax. The constant growing of wheat gradually decreased the yield from year to year until it was found necessary to introduce other crops for the purpose of rotation. The farmers have been forced to realize the importance of crop rotation and the successful farmers are at the present time growing a succession of crops.

In the early days the soil was so productive and gave such good yields of wheat year after year that the average settler considered it as inexhaustible. For this reason some land in the county has been so badly run down that only rotation and careful cultivation will ever bring it back to its former productiveness.

Upon the heavy, flat areas adjacent to the Red River considerable difficulty is experienced with the wheat crop during wet years, and for this reason it is often difficult for those who rent their farms to obtain desirable tenants. The landowners find that letting their farms out to tenants is often very unsatisfactory for the reason that the renter seldom takes the same interest in improving the soil and keeping up repairs as does the owner.

The following dates are about the average time of seeding: Wheat, April 1 to 10; barley, April 20 to May 10, sometimes a little later;

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flax, May 15 to June 10; corn, May 8 to 20. It is considered that the latter part of August is the best time for sowing rye, although some of it is sown just before the ground freezes. Barley is the first crop to be harvested, which is generally the latter part of July. Wheat and oats are usually harvested in the early part of September.

Practically all of the wheat grown in the region is spring wheat, the winters being too severe for winter wheat.

The Twelfth Census returned the acreage of wheat in 1899 as 317,746 acres. According to the county records the production of wheat has ranged from less than 2,000,000 to more than 4,000,000 bushels annually for the last five years, although within the last three years there has been considerable decrease in the acreage. The rotation of crops has been one of the causes for this decrease. The census gives the acreage of oats in 1899 as 57,016 acres. Since that time there has been a considerable increase. The production in recent years has ranged from 1,000,000 to 2,250,000 bushels. The acreage in corn in 1899 was 10,110 and in barley 8,937 acres. The production of flax in recent years has ranged from 21,000 to 30,000 bushels annually. The census returned the acreage in 1899 as 39,564. All of the wheat and flax is shipped to eastern markets, except a small amount of wheat which is consumed by the local mills. Practically all the hay and corn and a considerable amount of the barley and oats are used for feeding purposes.

The grain is thrashed as soon after harvest as possible. Some of the grain is stacked, but a large proportion is handled from the shock. In the latter case more men are required and the cost of thrashing is therefore considerably higher. There are two advantages in having the grain stacked for thrashing—the cost is considerably less and there is less loss of grain. Where the entire crew is furnished by a thrasher the following prices are about the average: Four to 5 cents per bushel for oats, barley, and spelt; 8 to 10 cents for wheat; 16 to 20 cents for flax. Where all of the crew and teams are furnished by the farmer the prices are approximately as follows: Two to 3 cents per bushel for oats, barley, and spelt; 5 to 6 cents for wheat; 8 to 10 cents for flax.

Twenty-five to 30 horsepower traction engines are generally used with a blow-stacker separator. Straw is usually the fuel used. Sometimes, however, portable gasoline engines are used in place of the traction engine. These have become more popular in the last few years.

Several of the more wealthy farmers own thrashing outfits, and do their own thrashing as well as that of some of their neighbors. The plan of exchanging work, one farmer with another, is now practiced in some parts of the county. In this way considerable expense is eliminated.

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Up to a few years ago stock raising was not common in the county, but since the yields of wheat have begun to decline this industry is becoming more important as an adjunct to general farming. Many of the more progressive farmers are now devoting about one-fourth of their farms to pasture or the production of hay. Sometimes, however, feed, such as corn or millet, is raised in place of pasturing the land. This is one step in the system of rotation. Cattle, horses, and hogs are beginning to be raised to a considerable extent. A very few sheep are also being raised. In 1907 county records show that there were about 21,000 head of cattle of all ages in the county, an increase of about 100 per cent in the last nine years. In the same year there were about 14,000 horses, about 7,000 hogs, and 2,000 sheep. The raising of sheep is declining, while the number of all other stock is increasing from year to year. The value of live stock is about $750,000.

Dairying is becoming an important industry. At the present time there are over 10,000 milch cows in the county. There are five creameries in active operation. Most farmers who are carrying on the dairy business have cream separators on the farms. Many make the cream into butter, while others ship it to St. Paul.

It is believed that great advantage will result from stock raising, for with only a small number of stock on the farm there is a sure income every year; whereas with grain growing alone there is an occasional year of failure. The straw that is now almost all burned should be used as feed or bedding for the stock, and thus converted into manure. If it is seen that the corn will not mature, it can be made use of for feeding purposes. On nearly every farm, particularly in the western part of the county, there is a considerable acreage of land that is uncultivable, owing either to lack of drainage or to the sandy nature of the soil, or to the roughness of the surface. Practically all of this unused land supports a good growth of grass, which should afford pasturage for five or six months of the year. Much of the uncultivated land of the western part of this county is now pastured, but there are still many square miles which are not bringing in any return, except the small amount of prairie hay that is cut from them.

The farm buildings of the county are generally fair. Large, well-constructed barns frequently appear. It is noticeable, however, that little care is given to housing the farm machinery, only a comparatively few of the farmers having sufficient shelter for the purpose.

In the northwestern part of the county there are a few cattle ranches. Some horses and a few sheep are also kept. There is considerable wild hay in this section of the county, but it is practically all consumed upon the ranches.

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The United States census of 1900 gives the average size of farms in Richland County as 318.7 acres. It is probably smaller at the present time, as the large farms are gradually being cut up into smaller ones. The total acreage in farms in 1900 was 719,051; the value of farm lands and improvements, except buildings, was $11,399,940.

The greater part of the farm work, even in harvest time, is done by the farmer and his family. About 71 per cent of the farms are operated by the owners, the remainder being rented on the share or cash system. In case the renter furnishes the seed and pays the thrashing bill he receives three-fourths of the crop. Where the owner furnishes the seed and pays half the thrashing bill, the crop is divided equally. In recent years some of the more prosperous farmers have moved into town, generally leaving the farms in the care of tenants.

The development of Richland County has been rapid, and its present prosperous condition has been reached in about twenty-five years. In the early eighties the best land in Richland County could be bought for $5 to $8 an acre, while at the present time the price of the same land ranges from $25 to $50. Thus much of the present wealth of the county is a result of the advances in the prices of the land, and at the present valuation the farmer will have to practice more intensive methods in order to realize a good percentage of profit on his investment. The rotation of crops and careful cultivation can not be too highly recommended. The fact that flax can not be grown on the same soil year after year demonstrates to the farmer that rotation is a necessity in order to get the best returns. The great variety of soils in the county present opportunities for many lines of farming, and it is not necessary to depend upon wheat as the money crop.

The most important problem in the county in connection with a diversified system of farming is to maintain permanently on the farms a number of live stock. Feed can be produced at a moderate cost from such crops as are necessary in a systematic rotation. A combination of timothy, clover, and brome-grass continues to give a good crop the fourth and fifth years. After these crops wheat will produce from 6 to 12 bushels more per acre.

Summer fallowing is quite general throughout the county and is becoming more so, especially upon the heavier soils. Plowing generally begins as soon as the grain is cut, and as much of the stubble as possible is turned under before the ground freezes. Some of the farmers burn the stubble, but as many of the fields need organic matter it is much better to plow the stubble under. Where the soil is very sandy it is not considered best to summer fallow it, because of the tendency of the soil to drift.

Most of the plowing is done by gang plows drawn by four or more horses. Some of the plowing, however, is done with traction engines, which turn from 8 to 10 furrows at a time. After plowing the land

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it is left until spring. If the farmers are rushed with work in the spring they sometimes dispense with plowing, and where the grain is to be sown upon sandy soil they merely disk the ground and drill the grain into the old stubble. The corn crop is generally planted in check rows and is cultivated with sulky cultivators. The cultivation is usually insufficient, and sometimes the ground between the rows is allowed to become filled with wild oats and other weeds and grasses. More thorough cultivation would materially improve the corn crop and at the same time keep down the weeds.

The extermination of wild oats and quack grass is one of the serious problems confronting every farmer. It is believed, however, that by crop rotation, and by thorough, clean cultivation in the case of cultivated crops like corn, much can be done to control these pests.

Potatoes are not grown except for home consumption. The lighter soils of the western part of the county are well adapted to them. This would be a profitable crop to include in rotation with grains. The yield ranges from 200 to 300 bushels per acre.

There are a few small patches of alfalfa in the county. Very little interest has as yet been taken in this crop, but it is believed that when properly handled it will do well.

As already noted, the farmers and their families do the most of the farm work. Some labor is hired by the month, however, the usual wage being $25 to $35 a month for a period of seven months. A little labor is hired by the year, and when such is the case the price per month is somewhat less than when hired for shorter periods. During harvest time a good deal of day labor is required, the wages ranging from $2.25 to $2.75 a day. At this season of the year much of the labor is supplied by transients who come from eastern sections to take advantage of the high wages. According to the Twelfth Census the farmers expended in 1899 $705,520 for labor.

Apples are being tried to some extent in this section, and it is hoped that in time a variety will be developed which will withstand the severe winters and mature its fruit during the short growing season. It is believed that the higher elevations in the western part of the county will be better adapted to fruit than the region of heavier soils adjacent to the Red River.

As a protection against the severe winds during the winter, nearly every farmer sets out a grove of trees on the north side of his house and farm buildings. Such rapid growing trees as the box elder, cottonwood, elm, and willow, are used for this purpose.

There are two sources of water supply in Richland County—surface wells and artesian wells. The former furnish a sufficient supply of water except in very dry seasons. An artesian supply may be found at depths ranging from 150 to 300 feet in most of the county, excepting the northwestern portion.

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Much interest is being taken at present in the question of drainage. Open ditches are now being constructed by the county and in the northwestern section the drainage of large areas, heretofore used only for grazing, is being undertaken. Each landowner is taxed according to the benefit he will receive. In these poorly drained areas some alkali is found, but it is believed that this will be removed when drainage is established.

SOILS.

The soils of Richland County fall naturally into three groups, namely, those of glacial origin, those of delta origin, and those of lacustrine origin.

The soils of glacial origin are confined to the southwestern corner of the county and include practically all of the county west of Hankinson and south of the Wild Rice River. This portion of the county was once covered by an extension of the ice sheet known as the Dakota glacier. As the ice sheet moved slowly southward it ground up the rocks, granite, gneiss, schist, limestone, shale, etc., over which it passed. This ground-up material was left as a veneer over the region upon the recession of the ice sheet. The surface features of this portion of the county are typical of a glaciated area, being made up mainly of low, rolling prairie with a succession of morainic hills, between which are often found kettlelike depressions. Through this portion of the county passes a chain of small, shallow lakes which extend from 6 miles northwest of Lidgerwood to Hankinson and southward. These lakes represent depressions in the glacial channel of the Sheyenne River. The soils in the southwestern portion of the county are derived mainly from the weathering of the unassorted glacial material, and the principal types represented are Fargo loam, Marshall loam, Fargo sandy loam, and Marshall gravelly sandy loam.

The remaining portion of the county was formerly covered by a great lake, known to geologists as "Glacial Lake Agassiz." At that time the whole of what is now the Red River Valley, including Lake Winnepeg, was one continuous sheet of water. The surface of the region formerly covered by the lake is so level that in traveling over it one is reminded of being at sea, the plain being visible for only a few miles ahead. The tops of buildings and grain stacks are seen first, after which they gradually come into full view. This levelness is well shown by the fact that at Wyndmere the altitude is 1,065 feet, while at Wahpeton, 28 miles directly eastward, the altitude is 960 feet. In a north and south direction the fall per mile is even less, the average being less than 2 feet.

At the close of the Glacial period the melting ice swelled the streams to many times their present volumes, and large quantities of sand, silt, and clay were carried along by the streams and spread out over the

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bottom of the lake. The Sheyenne River at that time emptied into Lake Agassiz at a point near the present site of Hankinson, and that portion of the ancient lake bottom covered by the sediments brought down by the river is known as the "Sheyenne Delta." The eastern boundary of the delta in Richland County is approximately a line connecting Colfax, Galchutt, Fairview Junction, Great Bend, and Oswald. All of the county west of this line, and not included in the glaciated area, belongs to the Sheyenne Delta. As would be expected, the soils derived from delta deposits predominate in sands. At the first checking of the river's current the coarser materials, like gravel and sand were deposited, while the finer sands and silt were carried farther into the lake. The gravels and sands were often reworked by the waves and piled up into beach lines, and this accounts for some of the small gravel areas in the western part of the county. The following are the main soil types derived from the deposits of the Sheyenne Delta: Fargo fine sandy loam, Fargo fine sand, and Fargo sandy loam.

The soils of lacustrine origin are confined mainly to that portion of the area between the eastern boundary of the Sheyenne Delta and the Red River. The materials from which these soils are derived represent the depositions which took place in the middle of the old lake beyond the influence of inflowing glacial streams. In these deep, quiet waters only the finer materials, like clay and silt, were carried in suspension. The region as a whole is flat and poorly drained and the soils are heavy. The following are the main soil types of lacustrine origin: Fargo clay loam, Fargo loam, and Fargo clay.

Besides the above classes of soils, there are several small areas where the sandy material of the Sheyenne Delta has been blown about and formed into dunes.

Associated with all of the soil types in the county there are sometimes small, swampy, poorly drained depressions, and these were mapped as Meadow.

The following table gives the names and areas of the various types of soil. The accompanying map distinguishes the soils by means of colors.

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Fargo fine sandy loam	218,112	23.5	Fargo clay	11,136	1.2
Fargo loam	204,800	22.0	Lidgerwood fine sandy loam	10,048	1.1
Fargo fine sand	144,256	15.5	Marshall gravelly sandy loam	10,048	1.1
Fargo clay loam	113,280	12.2	Wabash loam	4,544	.5
Marshall loam	91,264	9.8	Fargo gravelly loam	3,840	.4
Fargo sandy loam	53,504	5.7	Walcott sandy loam	3,264	.4
Meadow	28,672	3.1			
Dunesand	19,008	2.0	Total	929,920	.....
Fargo silt loam	14,144	1.5			

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FARGO CLAY.

The Fargo clay to a depth of 15 inches is a very heavy, tenacious, black clay. The subsoil is practically the same as the soil, although it is a little heavier in texture and lighter in color, being blue or mottled. When wet the soil is very gummy and sticky and frequently clogs the wagon wheels. It is locally known as "gumbo," and is the heaviest soil found in the area. Pockets of gypsum are frequently encountered in the subsoil and decomposed limestone nodules forming gray or white spots are sometimes found.

Practically all of the type is covered by a growth of wild grass and very little of it is cultivated. Occasional barren spots occur, which are due to the presence of alkali, but they are not of sufficient size to be of importance. It is the most difficult soil in the area to cultivate. When broken it forms very large clods which bake hard, and considerable harrowing is necessary to put it in fair condition. The mechanical condition is much improved by the application of straw and coarse manures. In dry seasons large cracks occur in the soil, which often extend to a depth of several feet.

The Fargo clay has a level to flat topography. It occurs in slight basins in the eastern part of the county, and occupies but a small percentage of its area. The largest body is found west of Woodhall, and is about 4 miles long and 1½ miles wide. The only cultivated areas occur south of Christine and along the northern border of the county.

Nearly all the areas of this soil are poorly drained, which accounts for the fact that little of it is under cultivation. In many places attempts have been made to drain the land, but with little success, except in the northern part of the county, which has been well drained by open ditches and is producing good crops. In many places the expense of draining the small areas is so great that reclamation is not practicable.

The soil is derived from reworked glacial débris and consists of the finest part of that material which was deposited in the center of the old bed of Lake Agassiz.

The Fargo clay is most commonly used for the growing of wild hay, although frequently the grass is not of good quality. A great accumulation of organic matter makes the soil very fertile. As so little of the type is cultivated it is impossible to give accurate crop yields.

WABASH LOAM.

The Wabash loam to a depth of about 18 inches is generally a dark-brown or black loam, which contains considerable organic matter. The subsoil is lighter in color and slightly heavier in texture than the soil; otherwise it is about the same. The soil presents some

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variation, however, in that it has a sandy loam and clay loam phase, but these occur in areas too small to be indicated. Stones and gravel are absent from both soil and subsoil.

The soil is found in a continuous strip bordering on both sides of the Sheyenne River for a distance of 8 or 9 miles. It is about one-half mile wide and extends from the west county line to Barrie. It is also found in the oxbows of the Red and Wild Rice rivers and to a small extent along Antelope Creek. The areas occurring along the Red and Wild Rice rivers are very small and generally contain considerable very fine sand.

The topography of the soil along the Sheyenne River is undulating, while along the Wild Rice and Red rivers and Antelope Creek it is practically level. The drainage is generally good, with the exception of the clay loam phase along the Sheyenne River.

The soil is of alluvial origin, being deposits of the streams along which it occurs. A sandy loam phase is found, where the soil is modified by material blown from adjoining sand areas.

Except the clay loam phase, which is sometimes too wet, the Wabash loam is easily cultivated, and is, in general, farmed. The uncultivated portion, occurring along the Sheyenne and Red rivers, is covered with a growth of timber consisting mainly of oak, ash, elm, and box elder.

The soil is adapted to the production of oats, wheat, barley, and corn. Wheat yields from 12 to 25 bushels per acre, varying according to the phase on which grown, and oats from 25 to 50 bushels per acre. Corn produces good yields, but along the Sheyenne River there is danger of it not maturing on account of early frosts. On the Wild Rice and Red rivers truck products are grown in gardens, where, owing to the light texture of the soil, it warms up early in the spring. The chief truck products are onions, radishes, potatoes, lettuce, beets, and cabbage. Potatoes are grown quite extensively and yield from 200 to 300 bushels per acre. The loamy phase is the most productive of the type.

The following table gives the results of mechanical analyses of the soil and subsoil of the Wabash loam:

Mechanical analyses of Wabash loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19595	Soil	0.0	8.8	3.5	23.1	9.8	38.6	16.3
19596	Subsoil	.0	3.7	2.4	17.8	10.6	39.6	25.7

The following sample contained more than one-half of 1 per cent of calcium carbonate ($CaCO_3$): No. 19596, 3.49 per cent.

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FARGO FINE SAND.

The Fargo fine sand consists of 10 to 12 inches of grayish-brown fine sand, underlain by a subsoil of lighter colored fine sand. The areas are composed of a succession of rounded mounds with broad, shallow, intervening depressions. The soil in these depressions is slightly heavier and deeper and contains more organic matter, which gives it a darker color. The knolls are from 5 to 15 feet high and vary in width from one-fourth acre to several acres in extent. The type sometimes occurs on slight ridges, evidently beach formations, which give it a gently rolling topography.

Owing to the peculiar topography the drainage is not generally good. The tops of the knolls are usually very dry, while the depressions are wet, some of them containing water the year around. Several short, deep channels cut through the sand dunes along the Sheyenne River and drain a portion of the soil. The drainage of the beach ridges is good. These occur in the vicinity west of Colfax, in the northwest corner of the county, and in the neighborhood of Hankinson.

About one-half of the area of Fargo fine sand is in a poorly drained condition, and such areas have been shown in the soil map by means of symbols. As would be expected, there is considerable variation in the soil of the swampy areas, especially as regards the organic-matter content.

The county is attempting to improve this soil by means of artificial drainage, and great interest is manifested in the question of its fertility and adaptability after being satisfactorily drained. In dry seasons, such as that of 1908, little drainage is necessary, except in the very lowest areas, but in ordinary or very wet years much of this type is under water, and for the last several years it would have been impossible to map the soil, as it was covered with water. None of the poorly drained areas are at present under cultivation.

This soil occupies the greater portion of the northwestern part of the county. The more swampy areas are found in Garborg, Homestead, Freeman, Sheyenne, and Viking townships. Two large areas in which the drainage is better occur—one north and the other south of the Sheyenne River. An area from 12 to 14 miles in length is found west of the Great Northern Railway near Walcott and Colfax, varying from about one-fourth mile to 3 miles in width. The other large area occurs west of Hankinson, where it is intermixed with several other types of soil. In the northwest corner of the county the type generally surrounds the sand dunes, and an area of considerable extent, surrounding sand dunes, occurs west of Homestead. Several small areas are scattered over the northwestern and south-central portions of the county.

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The Fargo fine sand is a delta formation, and it has been reworked to some extent by the winds, which accounts for the presence of many low knolls. The sand extends to a depth of more than 3 feet, except in a small area bordering the Sheyenne channel. The entire delta, and hence the Fargo fine sand, is underlain at from 4 feet to unknown depths by a stratum of clayey silt. South of the Sheyenne River in the cuts of the short channels the silty material outcrops. Here, though the land is broken, good crops are grown, owing to the fact that this heavier stratum is near the surface. In the northwestern part of the county the silt is covered by a shallower deposit of the sand than elsewhere.

The native vegetation consists of a good growth of prairie grass, with occasional areas of scrubby timber or bushes. Russian thistle appears in great quantities along the roads upon soil which has been broken and allowed to revert to sod. A large proportion of the type is used for pasture. Good prairie hay is cut in the wetter areas and, when the season is favorable, on some of the higher land. The greater proportion of the soil is uncultivated, but a considerable area along the Sheyenne River and north of it produces good crops. Here the characteristic knolls are less numerous and the surface is more level. Generally when recently plowed the soil is shifted by the wind, and on this account the sod or stubble is seldom broken until spring.

The Fargo fine sand yields from 8 to 12 bushels of Bluestem or Fife wheat, but it is better adapted to the macaroni or durum varieties. Oats and corn produce fair yields, but not as good as on many of the other soils of the area. Owing to the lack of organic matter in the soil crop rotation is very essential.

The following table gives the average results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Fargo fine sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19567, 19597	Soil	0.1	0.5	1.4	62.3	25.2	7.1	3.2
9568, 19598	Subsoil	.1	.3	1.3	67.4	20.7	3.9	6.0

DUNESAND.

Dunesand to a depth of 6 inches consists of a fine gray sand underlain by a yellow sand of practically the same texture. The only difference between the soil and subsoil is the presence of slight quantities of organic matter in the former which gives it a darker color and a somewhat loamy texture. In barren areas the soil and subsoil are identical, both being a yellowish fine sand.

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Most of the Dunesand occurs in three comparatively large areas. The largest of these borders the Sheyenne River in the northwest corner of the county, the next largest is found northwest of Hankinson, and the third occurrs near the county line west of Homestead. Smaller areas are scattered throughout the Fargo fine sand.

The surface of the soil is rough and broken, and composed of knolls and hills which rise abruptly from 25 to 125 feet above the surrounding prairie. The soil in the intervening depressions generally bears a fair growth of grass, and is more fertile than that on top of the knolls, which is frequently barren and constantly being moved by the wind. In the deeper depressions and along some of the slopes a stunted growth of scrub oak and choke cherry appears. There is an excess of drainage from the hills to the intervening depressions, which contain water in wet seasons.

Dunesand is a delta deposit which has been reworked by the winds, and probably varies in depth from a few feet to over 150 feet.

The type is uncultivated, and has scarcely any agricultural value. It is held at $5 to $10 an acre for pasturage, but if pastured too closely it soon becomes barren, and is then drifted by the wind. The greater proportion of this soil used for grazing occurs in the northwestern part of the county.

FARGO CLAY LOAM.

The soil of the Fargo clay loam to a depth of 12 inches consists of a black clay loam containing a high percentage of organic matter. Below this to a depth of 18 inches the soil is a lighter colored clay loam, and frequently a clay. The vegetable matter content decreases with depth, and consequently the subsoil to a depth of 18 to 36 inches is a lighter color than the soil. The typical material is a dark-yellow stiff, silty clay or yellow clay, sometimes containing decomposed lime nodules, which form white spots, and pockets of gypsum crystals.

Some gravel is occasionally found in both soil and subsoil, but this is not characteristic of the type. The largest quantity was found in an area about 8 miles long, extending north and south, the greater portion being north of Wahpeton. This was practically the only area where gravel was noticeable to any extent, and here it occurred mostly in the subsoil.

The soil is very uniform and only slight variations can be detected, even in widely separated areas. Sometimes the gradation zone between this and other types is rather broad. The type is generally bordered by the Fargo loam, and in many places along this boundary both soil and subsoil are a little lighter in texture. There are occasional spots where the subsoil approaches a heavy silt loam, this being most noticeable southwest of Abercrombie.

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Another slight departure from the type was encountered in small areas in depressions. Here the soil is a little heavier and frequently extends to a depth of 24 inches with very little change in texture or color. The subsoil from 24 to 36 inches is much darker than that of the true type, being a very dark yellow or drab color, while the texture is a stiff clay. The areas covered by this phase are generally small and of comparatively little importance.

The Fargo clay loam is sticky when wet, and appears to be quite difficult to cultivate. When plowed it breaks into large clods. However, after these have been subjected to the weather and are dry they crumble beneath the harrow and form a good seed bed. Even if the soil is plowed when slightly wet there is not much difficulty in getting it in a good mechanical condition. During the summer, when the soil is comparatively dry, the first 4 or 5 inches is very loose and may be very easily dug up by hand. Below this the soil is moist and sticky.

The Fargo clay loam and Fargo loam are closely related. The surface soil of the former is generally a clay loam, though in some cases the first 4 inches may be a loam, and where the loam exceeds 4 or 5 inches in depth it is mapped as Fargo loam.

Practically all the Fargo clay loam occurs in the eastern part of the county. About four-fifths of the type is found in one rather broad, uniform area parallel to the Red River, which flows almost due north. This area extends from the northern boundary of the county, at which point is about 7 miles wide, southward to a point 7 miles south of Wahpeton. It is broken but once by an area of Fargo loam about 2 miles wide, although there are some included areas of Fargo clay and Fargo loam. The next largest area is found west of Tyler. The remainder of the soil is in comparatively small spots.

The soil is drained by the Red and Wild Rice rivers. Most of it occurs as a broad, slightly depressed basin, which reaches its greatest elevation along or near the streams, the height gradually diminishing as the distance from them increases. The soil has the poorest drainage of any of those used for farming. During an average season it has sufficient drainage, with the exception of an occasional depression, but in seasons of excessive rainfall crops are sometimes damaged. In some places ditches are utilized to carry off the surplus water.

The Fargo clay loam is one of the most productive soils in the county and has contributed much to the fame of the Red River Valley as a wheat-growing section. It retains moisture well and during droughts crops frequently flourish while those on the lighter soils suffer badly for lack of moisture. It is particularly well adapted to wheat, oats, barley, and flax. Corn grows well, but its chances for maturing are not as good as upon some of the lighter and better

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drained soils. Wheat ordinarily yields from 12 to 25 bushels per acre, and where crop rotation is practiced the yields in good seasons reach 35 bushels. Corn yields from 35 to 50 bushels per acre; oats from 35 to 60 bushels per acre; and flax from 7 to 12 bushels per acre. Where native grass appears it is luxuriant.

The following table gives the results of mechanical analyses of fine-earth samples of the soil and subsoil of this type:

Mechanical analyses of Fargo clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19589	Soil	0.0	5.0	3.8	7.3	6.0	37.6	40.3
19590	Subsoil	.0	3.1	1.9	8.4	4.1	34.6	47.8

FARGO SANDY LOAM.

The surface soil of the Fargo sandy loam is a dark-brown to brown fine sandy loam to a depth of 18 inches. From 18 to 24 inches a yellowish sandy loam is found which contains more fine sand than the material above. Immediately below this to a depth of 36 inches is a grayish-yellow silt loam in which the finer grades of sand predominate. Gravel is often found in small quantities in both soil and subsoil, the proportion being greater in the subsoil. This was most noticeable along the Wild Rice River, where generally a narrow strip about one-fourth mile in width occurs on either side of the stream. From a depth of 12 to 20 inches the sand is somewhat coarser than in the surface soil.

The Fargo sandy loam is somewhat similar to the Fargo fine sandy loam, and the two are generally associated. The principal difference is that the Fargo sandy loam has a silty subsoil, while the Fargo fine sandy loam has a sandy loam subsoil. It was difficult from the surface to make a distinction between the two types, and in tracing the boundary lines it was necessary to make a large number of borings.

Owing to the sandy nature of the soil, it is very easy to cultivate. Only a few stones are found in the soil. The soil is generally very uniform, there being only one or two variations, the greatest of these occurring west and southwest of Barney, where the surface soil was quite heavy, approaching a loam. In this vicinity there is a stratum of 6 or 8 inches of very fine yellowish silty sand between the soil and the subsoil. Occasionally the silty material of the subsoil is not encountered until a depth of 30 inches is reached, the soil being a sandy loam to this depth. Where the silt was barely reached at a depth of 3 feet the soil was classified as Fargo fine sandy loam.

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The Fargo sandy loam is located chiefly in the southwestern part of the county, near the Wild Rice River, and extends from the county line, west of Wyndmere, to within a few miles north of Hankinson. The only other areas of importance are found south and west of Hankinson, for the most part near the old Sheyenne channel, which crosses this section of the county. The soil usually occurs in comparatively large areas, and there are only a few that cover less than half a section.

The topography is generally undulating, but on account of the short channels reaching back from that stream it is slightly broken along the Wild Rice River, which drains the greater part of the type. As the areas generally have an elevation of from 20 to 60 feet above the normal water level of the stream, the drainage is good. In the vicinity of Wyndmere, where it borders the Fargo fine sandy loam, the soil is nearly level and is not so well drained, but crops do not suffer except in very wet seasons.

The soil is derived from reworked glacial material, but the Wild Rice River in times of overflow has deposited the gravel and some coarse sand.

The soil appears to be free from alkali, but an abundance of lime is evidently present, as the gray silty material contains a large percentage of carbonate.

This soil is the most desirable sandy loam in the area for general farming. The silty subsoil holds water well, so that the type withstands drought very satisfactorily. Where the silty subsoil is within 12 to 20 inches of the surface the soil is more desirable than where found at a depth of 30 inches, as the crop yields are generally better. The soil is well adapted to all the crops generally grown in the county. There is a small area along the Wild Rice River which is not farmed, owing chiefly to the fact that it is cut by stream channels, and is, therefore, too rough for cultivation. Wheat yields from 15 to 25 bushels and oats from 25 to 40 bushels per acre. Barley yields from 20 to 40 bushels and flax from 8 to 15 bushels per acre. However, there is little of the latter grown at present. The soil ranks among the best in the county for the production of corn and durum wheat. It is not often that corn fails to mature on this type when an early variety is grown, and yields of from 35 to 60 bushels per acre are secured. The soil is also well adapted to potatoes and various other truck products.

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The following analyses of soil and subsoil show the composition of the fine earth of the Fargo sandy loam:

Mechanical analyses of Fargo sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19551	Soil	0.0	0.4	0.4	16.1	38.6	39.9	3.9
19552	Subsoil	.0	.5	.4	4.9	28.7	57.1	8.2

The following sample contained more than one-half of 1 per cent of calcium carbonate ($CaCO_3$): No. 19552, 9.05 per cent.

MARSHALL GRAVELLY SANDY LOAM.

In general the Marshall gravelly sandy loam to depth of 10 inches has a dark-gray color and is composed of a light loam or a heavy sandy loam which contains a relatively large proportion of coarse sand and fine gravel. The subsoil to a depth of from 10 to 36 inches consists of a sandy silty material containing some gravel, the content of which increases with depth. Sometimes the gravel and sand in the subsoil are irregularly stratified. Both soil and subsoil have a number of variations, but the material is so complex it is impossible to separate them.

The topography is broken and hilly, being composed of morainic knolls and hills with intervening depressions or sometimes small valleys. On the tops of the knolls and hills the soil is generally loam, and it was frequently impossible to make a boring more than 12 inches deep, the subsoil in such places consisting of coarse and fine gravel and coarse sand. Along the slopes the soil becomes more loamy and the gravel content generally decreases toward the foot of the hills. In the intervening depressions the soil is usually a black loam containing considerable quantities of organic matter to a depth of about 15 inches. Here the subsoil from 15 to 36 inches is a rather heavy, yellow silty clay. These phases occur only in spots of a few acres. In some of the depressions water is found until early summer. Glacial bowlders, consisting of granite, gneiss, schist, and limestone, are frequently scattered over the surface, being most numerous in the vicinity of Elsie Lake. In some places where they occur in large numbers they are shown on the map by symbol.

Not over one-third of this type is under cultivation, the fields being located chiefly on some of the slopes and in a few depressions where the soil is better than the average. Where gravel and stones appear the soil is sometimes difficult to cultivate, but where these are not numerous very little trouble is experienced. Such areas, however, are comparatively small. The hilly topography makes the use of improved machinery laborious.

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The larger bodies of the Marshall gravelly sandy loam occur southwest of Hankinson, where there are areas containing more than 2 square miles. Between Hankinson and Lidgerwood, south of the old channel of the Sheyenne River, there is a continuous strip bordering this channel. The next larger area is found west of Lidgerwood along the county line. Northwest of Lidgerwood on both sides of the old channel of the Sheyenne River are found many small ridges and knolls of this soil. The small ridge south of the Wild Rice River is part of an ancient beach formation.

Areas of this type lie at altitudes over 1,100 feet above sea level, and the highest point in the county occurs on this type southwest of Hankinson, where the altitude is about 1,280 feet. On account of the gravelly and sandy nature of the soil and its rolling to hilly topography the natural drainage is excessive, except in the depressions. The drainage is chiefly into small lakes found throughout the areas; the greater proportion of the gravel and stones is found bordering these lakes.

The Marshall gravelly sandy loam consists of glacial deposits which are terminal and ground moraine. None of the type south of the Sheyenne River has been reworked by water, but the smaller areas north of the channel have the appearance of having been slightly altered by the action of water.

A slight trace of white alkali occurs in a few of the small depressions, and in some of the larger lakes the water contains considerable alkali. In no case, however, is the amount sufficient to be of any importance.

The native vegetation consists of prairie grass, and slough grass of poor quality for hay is found in the depressions. A few small oak, elm, and box-elder trees border some of the lakes. No accurate estimate can be made of the crop yields, as they vary on the different phases. Wheat, oats, and flax are grown and a few apple orchards are found. This type is probably better adapted to apple growing than any other in the area, especially in areas having a silty clayey subsoil.

The results of mechanical analyses of fine-earth samples of the soil and subsoil of the Marshall gravelly sandy loam are given in the following table:

Mechanical analyses of Marshall gravelly sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19569	Soil	10.4	20.4	9.4	14.0	10.8	28.8	6.
19570	Subsoil	9.9	14.3	4.1	8.2	7.8	40.1	15.9

The following sample contained more than one-half of 1 per cent of calcium carbonate ($CaCO_3$): No. 19570, 36.40 per cent.

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FARGO FINE SANDY LOAM.

The surface soil of the Fargo fine sandy loam to a depth of 6 inches is a dark-brown fine sandy loam containing considerable organic matter. From a depth of 6 to 12 inches the soil has about the same texture, but is slightly lighter in color, indicating the presence of less organic matter. The subsoil to a depth of 18 inches is slightly heavier than the soil and is of a yellowish or grayish color, becoming slightly lighter in color at a depth of 30 inches, and at 36 inches contains considerable more fine sand. It is sometimes mottled with red and white and continues to a depth of at least 4 feet, as shown by cuts and ditches, where it is underlain by a silty clay of unknown depth. This latter material is usually a bluish-drab color, mottled with white, evidently the result of decayed limestone nodules, and with red and black. This stratum of heavy subsoil underlies practically all of the Sheyenne Delta at varying depths, and comes to the surface in limited erosions south of the Sheyenne River. It appears nearer the surface in the heavy phase of the type and at the surface in the Fargo silt loam.

The Fargo fine sandy loam forms about 23 per cent of the area of the county, having an extent of about 341 square miles. It is the predominant type north of the center of the county, while large areas of it are found in the southeastern part. In the area north of the Sheyenne River the silty clay substratum lies from 4 to 10 feet below the surface. Between Wyndmere and the sand dunes along the Sheyenne River it is broken by areas of the Fargo fine sand, too small to be shown on the map, and by other areas of the same type, which extend into this locality from the vicinity of McLeod, in Ransom County.

In the vicinity of Great Bend and also in the southern part of the county the Fargo fine sandy loam forms the better class of farming land, and in the former locality some of the most prosperous farms in the county are found. The small areas that occur interspersed in other soils are generally good land. In the southern part of the area the sand dunes and Fargo fine sand border the Fargo fine sandy loam and are closely associated with it in origin and formation. Where the type borders the former it is somewhat sandier than the typical soil. On the other hand, where it borders heavier soils it has a slightly heavier texture. In both of these cases there is no distinct dividing line between the soils, and the soil conditions in the zone of gradation are frequently complex.

An important instance in the modification in the Fargo fine sandy loam due to the influence of another type of soil is found in the southern part of the county, where it grades into the Fargo loam. Here there is a strip of country about 1 mile wide and 5 miles

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long where the soil is slightly heavier and is considered a little more fertile than the typical soil.

The topography is undulating to slightly rolling and practically all areas have good drainage, except those lying next to the Fargo fine sand, where, in wet seasons, the drainage is inadequate. Antelope Creek is the only stream of any size flowing through the type, and bordering this creek the soil has its highest elevations. Some of the drainage passes through the Wild Rice River, but evidently a large part of the rainfall seeps into the soil and is carried off underground.

The Fargo fine sandy loam is found entirely within the area of the Sheyenne Delta and is derived from reworked glacial material brought to its present position by the Sheyenne River. It represents the finer deposits of the delta, along the western and southern edges of which it lies.

There are occasional slight indications of alkali in the soil, but the quantity is not sufficient materially to injure crops. The alkali is found chiefly in areas of deficient drainage.

The soil is easily cultivated, and it is generally farmed, though there are a few areas left for hay, of which the yield and quality are good. There is no apparent reason why these areas should not be cultivated, if this were desirable. Wheat, oats, barley, and corn are the principal crops, with some flax. Macaroni or durum wheat is much better adapted to the soil than the Fife or Bluestem varieties. The type is excellent for corn, and some of the best crops in the area were seen growing on this soil. In some fields corn reached the height of 10 feet. The earlier varieties mature in average seasons. Small grains yield nearly as well on the Fargo fine sandy loam as upon the Fargo clay loam, but the former is not as durable as the latter and crops should be rotated in order to maintain its productiveness. Various truck crops are also well adapted to this type.

Fargo fine sandy loam, heavy phase.—The surface soil of the Fargo fine sandy loam, heavy phase, consists of 8 or 12 inches of fine sandy loam which to a depth of about 10 inches contains considerable organic matter. From 10 to 20 inches the material is a yellowish fine sand and underlying this to a depth of 3 feet or more is a heavy, drab-colored clay or clay loam, usually mottled with white or grayish calcareous silty material due in part to decomposed limestone concretions. Where the silty material is absent the subsoil is usually a clay. Though somewhat heavier than the typical soil, this phase is friable and easily cultivated. It does not bake or puddle and the heavy subsoil, which retains water well, enables the crops to withstand drought.

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Areas of this phase occur chiefly in the vicinity of Mooreton, in the central part of the county. The topography is generally level, and owing to the impervious nature of the subsoil there is very little seepage. A small coulée in the eastern part of the largest area carries off the greater portion of the drainage water.

The soil occurs near the edge of the delta, and the subsoil is a heavy phase of the stratum of silt which underlies the greater part of the delta. In the low spots there is a slight indication of alkali in the soil, but not sufficient to be injurious to vegetation. The subsoil contains a considerable percentage of lime, derived largely from decayed limestone.

The greater proportion of the heavy phase of the Fargo fine sandy loam is under cultivation, and the crops are generally good. Occasionally there are small areas that are uncultivated. The soil is well adapted to grasses, such as timothy, brome grass, and clover. Where native grass appears, it is of good quality and yields from 1 to 2 tons of hay per acre.

The following table gives the results of mechanical analyses of the soil and subsoil of the two phases of the Fargo fine sandy loam:

Mechanical analyses of Fargo fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19555	Soil	0.2	0.3	0.8	27.0	44.0	23.7	3.5
19556	Subsoil	.0	.1	.5	23.3	55.5	18.0	2.5
Heavy phase:								
19593	Soil	.0	2.4	.5	47.3	20.8	22.3	6.4
19594	Subsoil	.0	1.9	1.5	19.2	12.7	46.0	18.0

The following sample contained more than one-half of 1 per cent of calcium carbonate ($CaCO_3$): No. 19594, 13.03 per cent.

MARSHALL LOAM.

The soil of the Marshall loam to a depth of 14 inches is a brown to black loam containing a large proportion of silt and a considerable quantity of organic matter. At 10 to 14 inches below the surface it becomes somewhat heavier in texture and lighter in color. The subsoil from 14 to 36 inches is a yellowish-gray heavy silt loam or silty clay. Where the surface is rolling some gravel is usually found in the soil, and it is generally found in the subsoil. There is some variation in the texture of the subsoil. It is heavier in the more level areas, which are generally found near the boundary line between this and the Fargo loam. A few stones are scattered over the soil, and both gravel and stone are frequently found surrounding the small lakes

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and basins and where the type joins the Marshall gravelly sandy loam. This soil is a gradation between the Marshall gravelly sandy loam and the Fargo loam, but has the same origin as the Marshall gravelly sandy loam.

The type is confined to the southwestern corner of the county, and is found principally north and south of Lidgerwood, where it covers low, gravelly hills. Two phases occur, one north and the other south of the old channel of the Sheyenne River near Lidgerwood, that north being somewhat modified by the action of the water, and that south being typical drift. The area in the extreme southwest is pitted by many small basins and potholes, which range in extent from a few acres to more than a section. The small areas contain water a large part of the year and have been represented on the map as Meadow. This is the principal type in the southwestern portion of the county south of the ancient Sheyenne channel.

The topography is generally rolling and sometimes slightly hilly, the more rolling portion occurring south and west of Lidgerwood. The more level or gently rolling areas lie in the extreme southwestern corner of the county, near the county line south of Hankinson, and in that part north of the old glacial channel. The areas range in elevation from 1,090 to 1,250 feet above sea level.

The drainage is generally good, the type being one of the best drained in the area, though occasionally there are small depressions of a few acres each in which drainage is inadequate. Even here crops are damaged only in seasons of abnormal rainfall. Much of the rain water passes into the soil, and is removed by underdrainage. The surface run-off drains into the Wild Rice River.

The soil is glacial in origin, and is derived mainly from morainal deposits, though in the more northern part of the area, which was near the shore line of glacial Lake Agassiz, the material has been subjected to some extent to the action of water.

The greater portion of the type is under cultivation. Native grass grows well on the uncultivated areas, which generally occur near the small lakes or where the type is more rough or gravelly. The soil ranks in general with the best soils of the county for general agriculture, there scarcely ever being an entire crop failure. It is well adapted to wheat, oats, barley, and corn. Oats yield from 20 to 40 bushels per acre, and wheat from 21 to 25 bushels per acre. Corn generally matures on this soil.

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The results of mechanical analyses of fine-earth samples of the soil and subsoil are given in the following table:

Mechanical analyses of Marshall loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19573	Soil	1.1	6.1	3.0	14.0	7.5	50.6	17.7
19574	Subsoil	1.4	4.5	3.7	11.7	8.7	41.3	28.4

The following sample contained more than one-half of 1 per cent of calcium carbonate ($CaCO_3$): No. 19574, 13.55 per cent.

MEADOW.

The term "Meadow" is used to cover the low-lying areas which are too wet to produce crops. The texture of the soil varies from sandy loam to clay loam, but it is generally a black loam overlying a black loam or clay loam containing a high percentage of organic matter. Occasionally the percentage of organic matter is so high that the soil to a depth of 10 or 15 inches presents the characteristics of muck. Areas of this nature are found in the old channel of the Sheyenne River and in a few of the larger depressions elsewhere.

There are two distinct phases of Meadow as mapped in Richland County. That part of the soil along the bottom of the Wild Rice River and in the old channel of the Sheyenne River constitutes one phase, while the small areas on the rolling prairie in the southwestern part of the county chiefly make up the other. The area along the Wild Rice River is an alluvial deposit varying in width from about one-sixteenth to a little over one-half mile, and follows the river from the western county line for about 20 miles, covering practically the whole bottom of the channel. The other phase is lake deposit or material washed from the hillsides into the depressions. The character of the soil varies according to that surrounding the depressions. During a wet season water stands in these throughout the entire summer, and they nearly all contain water at some season of the year. Frequently in the old Sheyenne channel the subsoil contains a large percentage of gray silty material, or it may be a gray, mottled impervious clay.

Meadow occurs generally in the southwestern part of the county, and a few scattering areas are found in the north and one larger area in the southeast. A comparatively large area of Meadow borders the Bois de Sioux and extends from about 1 mile north of Fairmount to the county line. The soil in this area is rather uniform in texture, being generally a clay loam underlain by a clay.

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The phase occurring along the Wild Rice River would be well drained if it were not for the impervious nature of the soil. There is no surface drainage over the remainder of the type. As the areas are usually small and scattered, the cost of draining them would be too great to make it practicable.

The topography is level or flat, the areas generally being surrounded by bluffs or hills. The areas along the Wild Rice River and the old Sheyenne channel are from 40 to 60 feet lower than the surrounding prairie.

None of the soil is under cultivation. It is covered with prairie and slough grasses, though often the latter is not of good quality. However, in some of the depressions good prairie hay is cut, the yields ranging from 1 to 2½ tons per acre.

WALCOTT SANDY LOAM.

There is an area in the northern part of the county where the soil varied so much within short distances that it was impossible to show the distinctions on a map of the scale used in the present survey. The materials were consequently grouped together and given the name "Walcott sandy loam," as the dominant texture of the surface material is a sandy loam. The soil varies from a dark-brown loam to a gray sandy loam and the subsoil from a clay to a sand. The profile may consist of a sandy loam 8 or 10 inches deep, underlain by a yellow sandy clay, or by a yellow sand. Where the top soil consists of a loam the subsoil is generally a yellowish-drab clay, but it is frequently a yellow sand or sandy loam. Another phase, composed of small sand mounds from 1 to 2 feet above the adjacent soil, is scattered through this type, and is practically the same as the Fargo fine sand. The sand extends to a depth of 3 or more feet and is sometimes drifted by the action of winds.

The topography of the Walcott sandy loam is level, with the exception of the small sand mounds or ridges already mentioned. A considerable part of the soil is poorly drained and uncultivated. It is in these areas of deficient drainage that the heavier phase is found. Excepting the sand mounds, which are always well drained, artificial drainage would benefit the whole type, especially during wet seasons.

The Walcott sandy loam is found in the northern part of the county near Walcott in a single area 5 miles long and 1 mile wide. It is the least extensive soil type in the county.

The soil is a mixture of Fargo fine sand, Dunesand, and Fargo loam. Some portions of the soil possibly have the same origin as the Fargo loam, but it is difficult to explain the formation of the type as a whole. The sand content of the level areas and the sand found in the dunes may possibly have been drifted originally from the Fargo fine sand which lies just west of the type.

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The crop yields vary with the character of the soil, and it is practically impossible to form an accurate estimate for the county as a whole. The undrained portions of the type are used for the production of prairie hay, and yields of 1 to 2 tons per acre are obtained. A considerable part of the uncultivated area is used for pasturage.

On account of the great variation in this soil no samples were collected for analysis.

FARGO SILT LOAM.

The soil of the Fargo silt loam is a brown silt loam 14 to 20 inches deep, with an average depth of 18 inches. The sand content is almost entirely of the fine and very fine grades and the content of organic matter is relatively large. The subsoil consists of a yellowish-gray or gray silt loam of practically the same texture as the soil. In some places the upper 4 inches of the soil are almost a fine sandy loam, and sometimes the subsoil consists of a drab or brown clay loam having a substratum of very fine, yellowish, sandy, silty material. This irregularity in the subsoil is found near the Fargo loam.

The Fargo silt loam as it occurs south of the Wild Rice River is frequently difficult to distinguish from the Fargo sandy loam, as the latter type in this vicinity contains considerable silt in the surface soil. When typically developed there are no stones or gravel in the soil or subsoil, though occasionally a small quantity of gravel is found in the latter. The area in the vicinity of Mantador and the one near the southern county line contain more fine sand than the area near the Wild Rice River on the western county line.

The soil is easily cultivated and can be put in a good state of productiveness without much difficulty. The small area near the jog in the western boundary line of the county, however, being lower and not well drained, is less valuable farming land.

The largest area of Fargo silt loam occurs in the western part of the county near the Wild Rice River. Two areas are located a few miles southwest of Mooreton and a small area is found in Freeman Township. Another small area occurs in the vicinity of Mantador, and a larger one is found near the county line in the southern part of the area.

The topography is generally undulating, and the soil is well drained, except a small area near the county line west of Wyndmere. The Wild Rice River receives the greater part of the drainage from the type.

The soil occurs within the Sheyenne Delta, and is therefore derived from reworked glacial material brought into Lake Agassiz during its higher stage. It is in this type that the stratum of silty clay, already mentioned as underlying much of the delta, comes to the surface, and it is the principal factor in forming the soil.

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The type is apparently free from alkali, but there is a considerable amount of lime in the subsoil.

Almost the entire area of the Fargo silt loam is under cultivation, and it is considered one of the best soils in the area. It is well adapted to timothy and other grasses, as well as to various small grains. Wheat yields from 15 to 30 bushels per acre, and macaroni wheat somewhat more. Oats yield from 25 to 50 bushels per acre. The native vegetation consists of prairie grass of good quality. The soil retains moisture well, and there is little evidence of any decline in its productiveness from year to year.

The following table gives the results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Fargo silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19557	Soil	0.2	1.4	0.8	7.1	10.8	70.1	9.6
19558	Subsoil	.0	.4	.6	4.0	13.9	69.1	12.1

The following sample contained more than one-half of 1 per cent of calcium carbonate ($CaCO_3$): No. 19558, 10.45 per cent.

FARGO GRAVELLY LOAM.

The Fargo gravelly loam consists of 12 inches of a brownish loam underlain by a dark-brown loam to a depth of 3 feet. A few glacial bowlders are scattered over the surface, and both soil and subsoil contain some gravel. The soil is closely related to the Marshall loam, which occurs immediately south of it. The chief difference between the two types is found in the subsoil. The subsoil of the Marshall loam consists of a gray, silty, calcareous material, while that of the Fargo gravelly loam is a loam or a slightly sandy loam. This may be due to the fact that the type under discussion is located within the area of the delta, while the Marshall loam is found chiefly outside of the old lake bottom.

The Fargo gravelly loam is located in the western part of the county, south of the Wild Rice River. The largest areas are found from 1 to 3 miles from its channel, and a few small areas are located nearer the channel. The topography is undulating to gently rolling, with a slight slope toward the Wild Rice River. The natural drainage is good. There are a few short, deep channels that have cut back from the stream to the type, but the areas adjoining these are not under cultivation.

The soil is of delta and beach formation, and occurs near the edge of the delta deposits. A ridge passing through the main body of soil is a part of the Herman beach of Lake Agassiz.

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The Fargo gravelly loam is generally easy to cultivate, though a portion of it has never been broken. Where not under cultivation the native prairie grass is good. There are no trees or shrubs occurring on the type. The principal crops now grown are wheat, oats, and corn, and the yields are about the same as on the Fargo fine sandy loam.

LIDGERWOOD FINE SANDY LOAM.

The soil of the Lidgerwood fine sandy loam generally consists of a brown or dark-brown fine sandy loam to a depth of 18 inches. Frequently the soil becomes slightly coarser in the lower depths. The subsoil is a light-brown medium sand frequently mottled with white and reddish material. The areas show some variation. In places the soil is a fine sand underlain by sand; in others a sandy loam underlain by sand or sandy loam. The lighter textured soil appears along the old channel of the Sheyenne River near Lidgerwood, where there is a slight ridge having some of the characteristics of a beach formation.

The soil is located in the southwestern portion of the county, bordering the old glacial channel of the Sheyenne River. It extends from the western county line in Dexter Township to a point about 4 miles east of Stiles, and occurs in the bottom of the channel and on the slopes and low hills bordering it.

In topography the Lidgerwood fine sandy loam varies from nearly level in the channel to rolling on the hills. A small proportion of the soil in the bottom is poorly drained, but that found on the slopes and on the hills is well drained.

The soil is of alluvial origin, being the deposit of the waters of the Sheyenne River during, or before, the earlier stages of Lake Agassiz. The fine sandy loam in the bottom is irregularly interspersed with areas of heavier deposits mapped as Meadow.

The type contains considerable organic matter and is very productive, especially in the hilly areas. It is easily cultivated, and the greater part is under cultivation. Some areas in the poorly drained bottom support a good growth of grass, which makes hay of excellent quality. Along the roads and in a few abandoned plowed fields some Russian thistle, locally known as "tumble weed," was observed. The chief crops now grown are wheat, oats, barley, and corn. The yields of small grains are not as good as upon the Fargo fine sandy loam, but corn should do exceedingly well on this type. Potatoes and other truck crops are well adapted to this soil, though not extensively raised at present.

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The following table gives the results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Lidgerwood fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19579	Soil	1.7	7.6	8.0	47.1	12.0	19.4	4.3
19580	Subsoil	1.2	6.1	6.9	52.1	16.6	12.0	5.3

FARGO LOAM.

The Fargo loam to a depth of about 15 inches consists of a dark or almost black mellow loam in which the sand content is practically all of the fine and very fine grades. Below this to a depth of 20 inches is found a yellowish loam, sometimes heavier in texture than the surface soil, and this grades at a depth of 3 or more feet into a yellowish silty clay containing in the upper portion some fine sand, the content of which decreases as the depth increases. Occasionally both soil and subsoil contain a small percentage of gravel, this being most noticeable in the area bordering the Red River north of Wahpeton. At the northern end of this area a few small bowlders occur on the surface. In a few areas the quantity of gravel was sufficient to warrant the use of a symbol in the map. It occurs here and there in beds on slight ridges or knolls, and is most abundant in the subsoil. Occasionally small bowlders appear on the surface. Surrounding this gravelly phase for some distance very little gravel is found in the soil, but it is reached in the subsoil at depths of 15 to 24 inches below the surface. Pockets of gypsum frequently occur in the subsoil, and partially decomposed limestone nodules are also encountered.

The Fargo loam is comparatively uniform. One of the most marked variations occurs along the contact with the Fargo sandy loam. In places there is a strip a half mile wide between the two types where the soil is not typical of either. Here the surface soil of the Fargo loam contains considerable more fine sand than the true type, and the subsoil is also lighter in texture, being in places a heavy silt loam containing a high percentage of fine sand and very fine sand. This phase is less productive than the remainder of the soil.

There is another phase, which consists of the areas bordering the Red and Wild Rice rivers, paralleling these streams and varying from one-quarter to 1 mile in width. Here the soil has at some time been affected to a certain extent by small alluvial deposits laid down by the streams. Along the Red River the influence of such deposits has been more marked than along the Wild Rice River. The soil generally occurs upon slight terraces, and as a rule is a very mellow

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loam containing more fine and very fine sand than the typical soil. There is not much difference, however, in the subsoil, although it is a little lighter both in texture and color. The highest percentage of sand in these areas was found north of Abercrombie, though the type generally has its heaviest texture in the northern part of the county.

The greater proportion of the Fargo loam occurs in one very irregular continuous area extending from the center of the northern boundary of the county to the southeastern corner. It varies in width from one-fourth mile to 13 miles, gradually becoming wider toward the south until it reaches its maximum width about 3 miles south of Fairmount. In the vicinity of Mooreton, and a few miles south of Barney, irregular areas of the main body extend toward the west. There are areas in which artificial drainage would be beneficial, but the main body of the type is well drained. Small depressions only a few rods wide are sometimes quite numerous. These are generally round and from 2 to 4 feet below the level of the surrounding country. Water frequently stands in these depressions until early summer. The soil in them is very black, and rich in organic matter, the first few inches sometimes having the characteristics of peat. Nearly all of these spots are found south of Wahpeton, very few being found in the northern part of the area. They were too small to be represented on the map.

The soil is easily cultivated. Both soil and subsoil are sufficiently heavy to hold a relatively large quantity of moisture and to retain it in time of drought. When the soil is broken up clods are formed, but these do not bake hard, and a good seed bed is easily prepared by light harrowing. The percentage of organic matter in this soil is generally less than that in the Fargo clay loam. It is probably not as strong a soil as the latter, but it is for the most part better drained.

The following table gives the results of mechanical analyses of a fine-earth sample of the soil and subsoil of the Fargo loam:

Mechanical analyses of Fargo loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19587	Soil	0.1	3.2	0.3	18.1	27.3	36.5	14.2
19588	Subsoil	.0	.4	.4	5.5	11.9	49.5	32.2

The following sample contained more than one-half of 1 per cent of calcium carbonate ($CaCO_3$); No. 19588, 6.15 per cent.

SUMMARY.

Richland County, N. Dak., area 1,453 square miles, is situated in the southeastern corner of the State. The eastern third of the county is flat or level. The remainder is quite rolling and in the

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western part some of the surface is rough. The county is drained by the Sheyenne, Red, Wild Rice, and Bois de Sioux rivers. These streams have few tributaries, and in parts of the county the drainage system is immature.

Although there is a wide range in temperature the climate is healthful. The rainfall is generally ample for crop growth. Nearly one-half of the annual precipitation occurs during the months of April, May, and June.

The population of the county is 19,379, the greater part being of foreign descent. Wahpeton, the county seat and the largest town, has a population of about 3,000. It is a junction point of several railroads.

There are four different railway systems in the county, which afford excellent transportation facilities, and, besides these, the Fargo and Southwestern, a branch of the Northern Pacific, passes within 1 mile of the northwestern corner of the county. There are 75 elevators in the county, which handle grain for Minneapolis and Duluth markets.

About 71.6 per cent of the farms of the area are operated by the owners. The tenanted farms are leased on a share basis, usually for one-half the crop. Wheat, oats, barley, and corn are the principal crops. Land ranges in value from $10 to $50 an acre, depending on location, type of soil, market facilities, etc.

The soils range from clay to sand and are derived from glacial material, either laid down as terminal and ground moraines, or as the same material reworked by streams and deposited in ancient Lake Agassiz, a part of these deposits being in the form of a delta at the ancient mouth of the Sheyenne River. Fifteen different soils, two of them phases of established types, are shown on the soil map.

The Fargo loam, 320 square miles or 22 per cent of the area of the county, is well adapted to general farming, producing good yields of wheat, oats, barley, and corn. The drainage is fair and crops seldom suffer from drought. This land is valued at from $30 to $40 an acre, and ranks among the best soils in the county.

The Fargo clay loam is the heaviest soil in the county cultivated to any extent. It generally contains a high percentage of organic matter and in average seasons produces excellent yields of small grains. In wet seasons, however, there is an excess of moisture and the yields are sometimes small. It is not well adapted to durum wheat, and Bluestem is generally grown. Its value is about the same as that of the Fargo loam, or possibly slightly less.

The Fargo clay is the heaviest soil in the county and is generally uncultivated. It occurs near the Red River and is poorly drained. Its organic matter content is very high, and with perfect drainage it would produce fine crops. It is a difficult soil to cultivate.

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The Fargo fine sandy loam, 341 square miles or 23 per cent of the area of the county, is the most extensive type mapped in the county. It is well adapted to general farming and especially to durum wheat and corn. It is valued at $20 to $35 an acre.

The Fargo sandy loam is very similar to the Fargo fine sandy loam, practically the only difference being in the subsoil. It produces slightly better yields than the latter type and its value is therefore slightly higher.

The Marshall loam occupies most of the unmodified drift area of the county, and the topography is from gently rolling to hilly. In seasons of excessive rainfall or of drought the soil is one of the best in the area, and an entire crop failure rarely occurs. It is valued at $30 to $40 an acre.

The Fargo silt loam covers a comparatively small area, but it is one of the best soils of the county, being well adapted to general farming. Its value is about the same as that of the Fargo loam.

The Wabash loam is the only alluvial soil in the county. It has a wide variation in texture, but all phases generally produce good yields.

The Fargo fine sand, Dunesand, and Meadow are types having the lowest agricultural value. They are practically all uncultivated, being generally used for hay or pasture land. The swamp phase of the first type is uncultivated at present because poorly drained. If reclaimed it would have a much higher crop value than the rest of the soil.

The Fargo gravelly loam covers small areas and is unimportant.

The county is generally in a prosperous condition and offers opportunities for various lines of farming and stock raising.

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SOIL SURVEY OF WESTERN NORTH DAKOTA.

By MACY H. LAPHAM and Party.

Description of the Area.

The soil survey of western North Dakota, the first step in a reconnoissance survey of the soils of the entire semiarid Great Plains belt, covers an area of 39,540 square miles, or slightly more than 56 per cent of the total area of the State.

The eastern boundary of this area is formed by the county lines following approximately the one-hundredth meridian and constituting the eastern boundary lines of the counties of Bottineau,

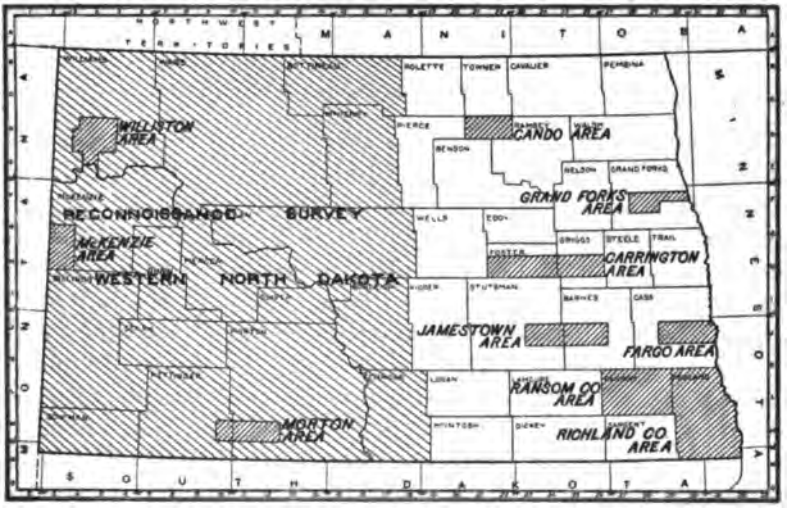

Fig. 33.—Sketch map showing location of the western North Dakota area.

McHenry, McLean, Burleigh, and Emmons. West of this line the survey covers the remaining portion of the State of North Dakota, extending upon the north to the international boundary line separating the area from the Provinces of Manitoba and Saskatchewan, of the Dominion of Canada, and to the west and south to the boundaries formed by the state lines marking the eastern and northern limits of the States of Montana and South Dakota, respectively.

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Within this area are included the counties of Williams, Ward, Bottineau, McHenry, McLean, Burleigh, Emmons, McKenzie, Billings, Bowman, Dunn, Stark, Hettinger, Adams, Mercer, Oliver, and Morton, seventeen in number and covering an area only slightly less than the total area of the State of Ohio, and greater than the combined area of the States of Maine and New Hampshire.

TOPOGRAPHIC FEATURES AND REGIONAL DRAINAGE.

The area surveyed is made up of portions of two great topographic provinces of the United States, the Prairie Plains and the Missouri Plateau, each marked by a variety of prominent, extensive, and distinct forms of land surface.

These differences are the result of the processes of nature as expressed by the weathering or decay of rocks, by degradation or erosion of the land surface, and by the deposition of material over the original land surface through the agencies of water and ice. It is due mainly to the latter agencies, as connected with successive encroachment and retreat of the great continental ice sheet, and to the degradation or wearing away of the land surface since the Glacial period by running water, that the striking and extensively developed physiographic features of the region have resulted.

Prairie Plains.

The northeastern portion of the area covering the extreme northeastern corner of Williams County, about half of Ward County, all of McHenry and Bottineau counties, with the exception of that portion of the latter occupied by the Turtle Mountains, and the northeastern portion of McLean County, is embraced within the topographic province of the Prairie Plains, although the surface here generally lacks much of the uniform, nearly level condition of these prairies as developed in the prairie States to the south and east. The region here consists of a treeless glaciated prairie, with nearly level to undulating surface, ranging in elevation from about 1,475 feet at Willow City, in Bottineau County, to about 2,000 feet along the western boundary. At Berthold, in Ward County, a little to the east of its western edge, the elevation is stated to be 2,088 feet, and at Portal, on the international boundary, 1,954 feet above sea level.

The lower and more nearly level portions of the Prairie Plains falling within the area surveyed, and covering approximately the northern two-thirds of McHenry County, the eastern two-thirds of Bottineau County, exclusive of that portion covered by the Turtle Mountains, and probably a small portion of eastern Ward County, were formerly covered by the waters of an ancient glacial lake, to which the name Lake Souris has been given. This lake was formed

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by the damming or holding back of the waters of the Souris, or Mouse, River by the glacier.

The boundaries of this lake, which is of earlier date than glacial Lake Agassiz once covering the Red River Valley in eastern North Dakota and western Minnesota, are now very poorly defined, and the lacustrine origin of the plains covering its bed, formed by sedimentation, is much less evident than is that of the level plains of the Red River Valley.

In the lower flat districts of southeastern Bottineau and northern McHenry counties, formerly covered by the waters of this lake, the general surface is level or gently sloping. It is marked by numerous lakes, among the larger of which are Buffalo Lodge and Smoky Lakes in McHenry County, and by sloughs and marshes. Here and there it is broken by the remnants of former beaches or by high dunes and occasionally by sloping to rugged hills. The lakes are often without outlet, and drainage of the plains has been but poorly established. This section, forming the most of what is locally known as the "Mouse River Loop" country, is traversed from southeast to northwest by the Mouse River, which here is a sluggish stream with few tributaries. It has a meandering course through a shallow valley of slight fall and of generally marshy character. It finally reenters Canada, where it has its rise, and eventually empties into the Red River of the North and Lake Winnipeg. The better drained portion of the bottom lands along this stream are sometimes quite heavily wooded. The morainic hills, remnants of the higher lands of the Missouri Plateau to the westward, which here received a covering of glacial drift, formed islands in the ancient lake. They are treeless or support only a sparse growth of shrubby bushes. The sand dunes are generally protected by a light growth of shrubs, but are sometimes of barren, drifting character.

In the more westerly portions of the area covered by Lake Souris the surface becomes of a more rolling or undulating character, consisting of sloping, drift-covered prairie lands or morainic ridges and hills altered and partially leveled by the waters of the lake.

Outside that portion of the Prairie Plains covered by Lake Souris, the lakes and marshes are less extensive, although small potholes of marshy character frequently occur, while larger areas of restricted drainage occupied by marshes and lakes, generally of a more or less intermittent character, are not uncommon. The sand dunes of the more easterly section of the Prairie Plains are here generally wanting, while the higher morainic hills or outlying remnants of the Missouri Plateau are much more infrequent.

This section of the area is drained by the Des Lacs and Mouse rivers, the only important perennial streams of the Prairie Plains within the area surveyed. Both of these streams enter Ward County

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from the Province of Saskatchewan and flow in a southeasterly direction, where the Des Lacs joins the Mouse River near Burlington, a short distance above Minot. From here the general southeasterly direction of the Mouse is continued to Velva, in McHenry County, where it swings to the east and northeast and enters the "Mouse River Loop" country.

Throughout the western and southern parts of the Prairie Plains these streams follow a much more direct course, flowing through deep, wide valleys carved during a period when the streams were gorged by melting ice. The valleys are generally from one-half mile to 2 miles in width, and the bottoms, which lie from 100 to 200 feet or more below the level of the surrounding country, are sometimes quite heavily wooded with oak, ash, and other timber growth, frequently interspersed with a dense growth of shrubs and vines. (Pl. A, fig. 1.) The sides of the valleys are steep and rough and frequently dissected by deep V-shaped ravines, or coulées [a]—immature valleys heading back in the adjacent elevated prairies. These coulées become very numerous and form a striking feature of the landscape along the western side of the Des Lacs Valley south of Kenmare and continuing through the Mouse River Valley below the junction of the Des Lacs with the Mouse to Velva. Each coulée is traversed by an intermittent stream of excessive fall, and in only a few of these coulées below Minot do terraces or bottom lands of any extent occur. These streams are now eating back into the sloping adjacent country.

The upper portion of the valley of the Des Lacs River has been obstructed by glacial detritus, forming a series of three picturesque lakes, the upper or Des Lacs Lake extending northward beyond the international boundary line and having a total length of about 30 miles.

Westward from these stream valleys, where not dissected by the coulées entering the valleys, the Prairie Plains stretch to the front of the Missouri Plateau as a uniform, treeless level or gently sloping body of land, often unbroken for many miles by hills or ridges, almost without drainage courses, and marked only by the presence of an occasional lake, marsh, or small draw. Here and there are found rounded or subangular bowlders deposited by the glacier. In northwestern Ward County occur a series of low areas of restricted drainage. Marshy places occur here from which a part of the water is removed northward by intermittent streams which form a part of the Mouse River drainage system.

Missouri Plateau.

Marking the western boundary of the Prairie Plains and extending in a southeasterly direction from the northeastern portion of

[a] The word "coulée" is here used in its local sense.

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Williams across Ward and the northeastern part of McLean counties, there occurs a prominent range of rounded hills, rising from 300 to 400 feet above the level of the plains upon the east. This range of hills forms the boundary between the Prairie Plains and Missouri Plateau sections. The latter comprises that portion of the Great Plains or High Plains drained by the Missouri River and has an elevation ranging from 1,800 to 2,700 feet. This region is composed of two distinct topographic subdivisions—the Coteau belt, or "hill" country as it is locally known, and the Missouri slope. The character of the land surface of the former is the result of deposition of glacial material, while that of the latter is principally the result of erosion of the land by running water.

THE COTEAU BELT.

The Coteau belt consists typically of a great expanse of rounded treeless hills of various heights, but more often rising to nearly the same level, between 150 and 200 feet. They generally present a rugged sky line, with well-grassed and not excessively steep slopes, though the sides are sometimes abrupt. They are frequently strewn with heaps and ridges of rounded glacial bowlders, usually of granitic or other hard rocks. These rocks, entirely unlike any of the country rock, have all been derived from a foreign source.

The Coteau section represents a terminal moraine, the most rugged and extensive of the many occurring in North Dakota. It covers a belt roughly some 40 to 60 miles in width, extending along or near the plateau front, where the progress of the glacier was probably checked by the original preglacial plateau escarpment. The backbone of the region, or belt of higher rounded hills and morainic ridges, is, however, generally from 15 to 25 miles in width. The depth of the deposits forming this moraine is stated by Willard, of the Agricultural and Economic Geological Survey of North Dakota, to be from 30 to 150 feet deep. The region covers about one-half of Ward, the greater portion of Williams, the most of McLean, and large areas in Burleigh counties.

The eastern face of the Coteau belt is marked by occasional coulées or immature valleys cutting deeply into the glacial drift and draining to the valleys of the Mouse and Des Lacs rivers. Immediately back from the face the hills increase in height, often blending into each other or occurring as rugged, irregular ridges, while between the bases of the hills occur countless meadows, marshes, and small lakes. The lakes occur at various levels and are generally isolated, though often near together. They are in some cases without outlet, of circular to irregular outline, and from but a few yards to several miles in diameter. Again, they may occur in chains occupying the beds of former stream channels which have been obstructed by glacial drift.

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Many of them are rapidly changing into meadow, owing to the filling of their basins with sediments washed from the adjacent slopes and with the decaying remains of water-loving grasses and other semiaquatic vegetation, while about their edges may occur remnants of former, more elevated beaches, bowlder chains, wave-cut terraces or cliffs marking the sides of the adjacent hill slopes. (Pl. A, fig. 2.)

This elevated Coteau belt, rising some 700 feet above the bottom of the adjacent Mouse River Valley upon the northeast, totally without streams of any importance whatever or drainage to outside sources, forms the watershed between the Hudsons Bay and the Missouri River drainage systems. Comparatively level or gently undulating amphitheaterlike areas may, however, be inclosed within the encircling ridges and hills, particularly near the western edge of the belt, where the morainic hills merge into the undulating and dissected land-forms produced by stream erosion.

MISSOURI SLOPE.

The Missouri slope has a much dissected topography. Where it merges with the Coteau belt, the western boundaries of which are extremely indefinite, it is cut by deep, broad valleys following irregular courses. These valleys were formed by streams which found their way from the edge of the melting glacier to the Missouri River drainage system. The region was not covered by the glacier itself at the time of the formation of the Altamont moraine, but the streams issuing from the ice front were loaded with glacial débris and laid down deep deposits along their courses. The region is known as the "overwash" belt. At present the valleys are usually occupied by minor creeks, generally of an intermittent character and but remnants of their former proportions, such as little Muddy Creek in Williams County, Little Knife and Shell creeks in Ward County, Douglas, Snake, and Painted Woods creeks in McLean County, Apple Creek in Burleigh County, and Beaver Creek in Emmons County. These valleys usually have steep sides or are inclosed by bluffs, the valley bottoms being usually nearly or quite treeless.

Farther to the south and west the surface begins to assume the general outlines characteristic of the vast treeless plains of the Missouri Plateau lying south and west of the Missouri River, and covering the whole southwestern half of the area surveyed. Here the general land surface, except when cut by stream valleys, consists of an undulating to somewhat sharply rolling prairie plain, marked by low, wide swales or valleys whose sides are of gentle slope and by an occasional conical or flat-top butte. Unlike the Coteau belt marking the eastern edge of the plateau, the lakes are of infrequent occurrence and drainage, and consequent degradation of the land forms has reached an advanced stage. The regional drainage is

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FIG. 1.—MOUSE RIVER AT MINOT, SHOWING TREE-FRINGED BANKS.

FIG. 2.—GLACIAL LAKE IN THE MORAINIC DISTRICT, NORTHERN BURLEIGH COUNTY.

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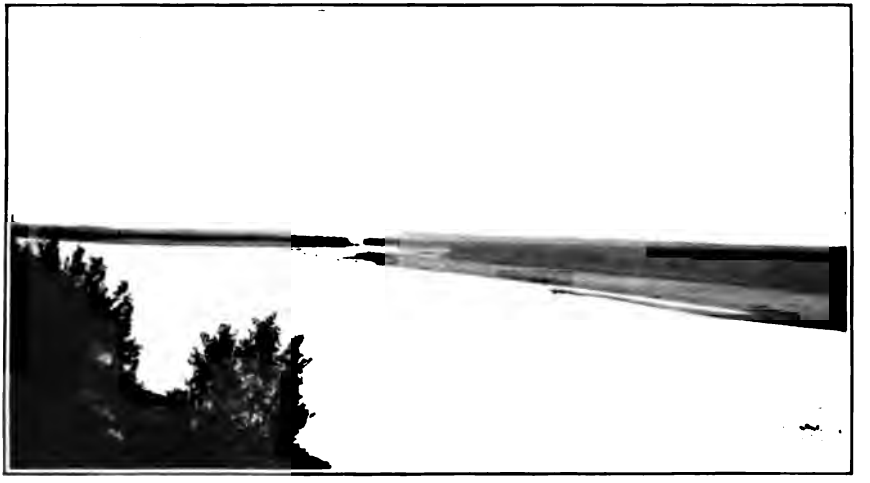

FIG. 1.—MISSOURI RIVER NEAR BISMARCK, SHOWING WOODED CONDITION OF THE WIDE, SANDY BOTTOMS.

FIG. 2.—MISSOURI RIVER AT WASHBURN.

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effected through the Missouri River, which, entering the area from the State of Montana and receiving the waters of the Yellowstone, flows westward, then southeastward, leaving the area near its southeastern corner.

The Missouri Valley is from 1 to 2 or 3 miles wide and lies from 100 to 400 feet below the adjacent upland plains. The stream is usually more or less obstructed by sand and gravel bars and bordered by broad flood plains, through which the river swings from side to side. The lower terraces usually support a dense growth of small timber. (Pl. B, fig. 1.) Steep bluffs border the valley on one or both sides, as at Washburn, in McLean County. Remnants of broad valleys, evidently at one time traversed by the stream, are of occasional occurrence. The most striking example occurs in the vicinity of the "Big Bend of the Missouri," within the boundaries of the Fort Berthold Indian Reservation, at which point the stream suddenly turns sharply to the southwest from its southeasterly trend, and after forming a broad U-shaped loop, regains its former direction. The two elbows of this loop are connected by an abandoned valley.

Entering the Missouri from a westerly direction, its most important tributaries, the Little Missouri, the Knife, the Heart, and the Cannon Ball rivers, the latter with its two forks—the North Fork of the Cannon Ball and the South Fork, or Cedar as it is locally known—drains the southwestern fourth of the State. These tributaries often carry large volumes of water during periods of melting snows and heavy rains in the spring and fall, but during the summer dwindle to insignificant streams or become dry channels occupied by occasional stagnant pools. The minor tributary creeks are frequently fed by springs of an intermittent character, while poorly drained, marshy areas about the headwaters or along the stream courses occasionally occur. With the exception of the Little Missouri, these four larger tributaries of the Missouri head near the southwestern portion of the area surveyed, and after following nearly parallel courses, flowing first in a southeasterly and then in a northeasterly direction, enter the Missouri at points nearly directly east of their headwaters. The valleys of these streams are from 100 to 300 or more feet in depth and sometimes reach a width of 2 miles or more. They are frequently marked by terraces and bordered by steep to sloping bluffs. Within their borders, as in the vicinity of Stanton, in the Knife River Valley, areas of drifting sands are sometimes found, and throughout the bottoms for a distance of many miles tree growth may be entirely wanting, though in other sections a considerable growth of timber and brush is not infrequent. The valley sides, particularly along the Knife River Valley, are often dissected by short intermittent tributaries entering at nearly right angles and following steep-sided valleys. These form extensive areas of broken land, eroded into character-

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istic "bad-land" forms and locally known as the "breaks," which the traveler upon the plains frequently encounters with startling suddenness.

BAD LANDS.

These areas of broken lands or "Bad Lands" occurring about the Knife River Basin and along the Knife River Valley are characterized by innumerable low, rounded hills separated by the broad, flat valleys of intermittent streams. The slopes are usually well grassed and are not excessive, although steep or vertical barren clay buttes and cliffs sometimes occur.

Other quite extensive areas of land eroded into the "Bad Lands" forms and marked by steep, high bluffs and bald buttes with fluted or furrowed sides occur along the Missouri and its tributary creeks, particularly in Williams and McKenzie counties. By far the most extensive areas of Bad Lands, however, occur in the area drained by Little Missouri River, which, rising in northeastern Wyoming near the Black Hills, enters North Dakota near its extreme southwestern corner, in Bowman County. (Pl. C, figs. 1 and 2.) The Little Missouri enters the Missouri River in Dunn County, after flowing a distance of 200 miles through the State.

The entire drainage basin of this stream is minutely dissected by small, short, greatly branched intermittent streams, which descend suddenly to the deeply intrenched valley of the Little Missouri, in places nearly 600 feet below the level of the plain. At Medora, where the Northern Pacific Railroad crosses, the elevation of the valley floor is 2,267 feet, to which point the railroad descends from Fryburg (elevation 2,768 feet), rising again to an elevation of 2,709 feet at the town of Sentinel Butte, 16 miles farther to the west.[a]

The main valley traversed by the meandering course of the Little Missouri, which during the summer is often subdivided into two or more streams finding their way through shifting quicksand and sand and gravel bars, is generally from one-half mile to 1 mile in width, the valley bottoms consisting of small terraces from a few feet to 30 or 40 feet above the stream. The higher terraces are usually covered with a growth of sage, while the lower support a dense growth of cottonwood, poplar, or other trees.

MONADNOCKS.

It is also in the region south and west of the Missouri that the flat-topped, higher buttes, capped by rocks resistant to weathering

[a] For statistics regarding the elevation of other prominent points within the area surveyed, and for a more complete description of its topography and geologic features, the reader is referred to the Second and Third Biennial Reports of the State Geological Survey of North Dakota, and also to the "Story of the Prairies," the last by Daniel E. Willard.

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and erosion, are most numerous and reach their maximum development. These usually occur in the vicinity of the divides of the streams and, rising to approximately the same height, form a series of monadnocks or remnants of an older, more elevated plateau which has with these exceptions been removed through the agency of stream erosion.

One of the most conspicuous of these monadnocks is Sentinel Butte, situated in western Billings County, near the station of the same name on the Northern Pacific Railroad. This butte rises 600 feet above the plain and 3,100 feet above sea level, reported to be the highest determined elevation in the State. Many others of similar character occur at intervals throughout the unglaciated part of the area surveyed. The more prominent of these are shown on the map.

OUTLYING REMNANTS OF THE MISSOURI PLATEAU.

The agencies of weathering and erosion giving rise to the monadnocks and Bad Lands of the western portion of the area have fashioned some notable landscape features in its eastern part. Conspicuous examples are the Dog Den Buttes—high rolling hills in northern McLean County—and the Turtle Mountains, covering a portion of northeastern Bottineau County. These are both outlying remnants of the Missouri Plateau, isolated by erosion of the intervening material by ancient streams, and subsequently modified by glacial action, their summits being covered or veneered by morainic drift. The Turtle Mountains form an elevated body of land some 40 by 25 miles in extent. They lie partly within the Dominion of Canada, and rise from 400 to 600 feet above the adjacent lacustrine plains. They consist of high, rolling hills somewhat dissected in places by coulées, and covered to the depth of from a few to 100 feet or more by glacial drift. They are densely wooded and dotted with marshes and beautiful lakes.

Other somewhat similar examples, but of less elevation and extent, are the rolling morainic hills and ridges occurring in the Mouse River Loop country in McHenry County, which, like the Buffalo Lodge Buttes near Granville, constituted former islands rising above the waters of glacial Lake Souris, their bases being sometimes bordered by beaches and their sides marked by wave-cut cliffs.

RELATIONS TO AGRICULTURE.

In each of the sections or regions briefly described the character of land forms resulting from the processes of deposition and erosion have exerted an important bearing upon the soils, the settlement of the country, and the development of agricultural pursuits.

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CHARACTER AND SOURCE OF POPULATION.

There are no large cities within the area, and with the exception of a comparatively limited number engaged in manufacturing, mining, and railroading the most of the population depends directly upon agriculture or upon lines of endeavor supported indirectly by agricultural pursuits.

The population of the area, considered as a whole, is cosmopolitan, nearly every State in the Union and many of the European countries being represented. Most of the native-born citizens have come from Minnesota, Iowa, Illinois, Wisconsin, Indiana, South Dakota, and the eastern districts of North Dakota. The population is, however, to a large extent composed of foreign born and their descendants, those of Scandinavian and German origin predominating.

The earlier settlers, who engaged in stock raising, were almost exclusively native-born Americans, although a few Germans and Scandinavians also figured in the development of this industry.

In the later development of farming the Scandinavian races have played a more important part, particularly within certain districts in the northern half of the area, where they sometimes form 50 per cent or more of the population. During still more recent years a large influx of immigrants of German-Russian and German-Hungarian origin has taken place. Most of these are descended from German ancestors who emigrated two or three generations ago to Russia, Hungary, or Bohemia. With some exceptions these people, most of whom speak the German language, have come directly from their native land and have but little or no knowledge of American agriculture. They, however, quite readily acquire such knowledge and are adopting American methods and the use of farm machinery.

PRESENT CONDITIONS AS TO SETTLEMENT.

As a rule, the foreign immigrant acquires land with the purpose of establishing a permanent home. Upon the other hand, a large proportion of the homestead claims so far acquired by Americans has been for speculative purposes.

In addition to these bodies of land acquired by the private individuals, extensive areas of land were granted by the Government to the Northern Pacific Railway, some of which are offered for sale. Additional tracts of vacant school lands, consisting of sections 16 and 36 in each township, have been granted by the State to each county and reserved as a means of revenue for school purposes. These school lands are sold at public auction, a minimum price being stipulated by law. But little of these lands has as yet been disposed of.

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FIG. 1.—BARREN CLAY BUTTES OF THE BAD LANDS, SHOWING LIGNITE SEAM AND PROJECTING COLUMNS, CAPPED BY RESISTANT LAYERS.

FIG. 2.—CHARACTERISTIC TOPOGRAPHIC FORMS IN THE BAD LANDS.

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Nearly all desirable public lands open to homestead entry have now been exhausted. In restricted areas in the more undeveloped sections of the State, as in portions of the hilly belt in Williams, Ward, and McLean counties, and in the comparatively unsettled districts of the western and southwestern counties, small tracts of desirable land subject to homestead entry are occasionally to be found. With but little exception, the larger tracts of land still open to entry are more or less hilly, broken, stony, or unproductive, and the smaller isolated areas of productive land are usually so located that some adjacent broken or unproductive land will be included within the 160-acre tract allotted the homesteader.

At present there is a tendency upon the part of the homesteader, anxious to obtain a free foothold for himself and family, to crowd too closely upon the limits of the "Bad Lands," or other hilly, broken districts. In such instances it is frequently the case that only a comparatively small proportion, sometimes not more than a fourth, of the homestead can ever be profitably cultivated. The attempt to extend the domain of agriculture, when divorced from the raising of stock, into these unfavorable sections should be discouraged, as the production of grains or other field crops alone upon but a few acres of land under the climatic and other conditions here encountered can hardly fail to result in disaster and in retarding the development of the State. The growing of hay or forage crops upon the favorably situated areas of limited extent, in connection with the grazing of stock upon the native forage of the broken areas, however, carries possibilities of success, provided the settler can acquire possession or use of enough land to support a mixed farming and grazing industry. In general, the homestead of 160 acres is insufficient for this purpose, and the areas of broken lands would better be left entirely to stock raising, or the homestead laws be so amended as to permit the homesteader in the more broken districts, under a thorough and careful system of classification and control, to acquire more than 160 acres.

However, while but little desirable public land open to settlement under the provisions of the homestead laws still remains, large tracts of tillable but unsettled and unutilized land still exist, title to which has passed to the individual, to the railroad corporation, or to the State. In most cases such lands can now be obtained by purchase. It is to the purchase and settlement of these private holdings that western North Dakota must look for its future development, rather than to further influx of immigration attracted by free homesteads.

In the older settled districts devoted to farming the larger proportion of the land is now producing crops and the farms are being rapidly improved, substantial farm buildings, generally shielded by wind breaks or groves of hardy trees, displacing the primitive homesteader's cabin and sod buildings. Many such older, well-settled

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districts occur in Bottineau, McHenry, and in eastern Ward counties, in the northeastern portion of the area. (Pl. D, fig. 2.) In western Ward and in Williams counties the buildings are generally smaller and large areas of unutilized private and State lands occur, while occasional tracts of public lands in the more hilly and stony districts may still be found.

In western Ward and in northeastern Williams counties rapid settlement and improvement of the land has recently taken place as a result of the completion of the Berthold-Crosby branch of the Great Northern Railway. In this section one sees many newly constructed farm buildings, freshly broken fields, and recently founded towns and shipping points, each with one or more grain elevators, the most conspicuous feature of the new town along the railway lines. (Pl. D, fig. 1.)

In the east-central and southeastern counties older towns and farming districts alternate with the new towns and the makeshift dwelling of the recent settler. Here, as in the more northern counties, large areas of unsettled private land occur, much of which is well adapted to cultivation. In the central and southern portions of Morton County in particular there are extensive unsettled districts, a considerable portion of the county lying south of the Cannon Ball River and being included within the limits of the Standing Rock Indian Reservation.

In the southwestern counties the older and larger towns and more thickly settled districts are usually confined to the sections traversed by the Northern Pacific Railway. Many of the towns and rural settlements here, however, have sprung up within the last few years. In the vicinity of the towns of Beach and Sentinel Butte, in western Billings County, near the Montana line, a recently settled district of considerable extent and locally known as the "Golden Valley" is now attracting attention, owing to the harvesting of unusually successful crops during the last two seasons.

In Bowman and Adams counties a considerable influx of homesteaders and other homeseekers, stimulated by the construction of the new Pacific coast extension of the Chicago, Milwaukee and St. Paul Railway, has recently taken place. Many of the newly located towns and settlements here form nuclei from which settlement is extending to the adjacent sparsely settled prairies. In all these counties of the southwest, however, extensive sparsely settled or unsettled districts occur. The conditions here, particularly in Bowman, Billings, and Dunn counties, are due in part to the character of the county, which to a considerable extent consists of Bad Lands unsuited to farming. There are, on the other hand, extensive areas of State and private land suitable for farming.

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In these sparsely settled districts of the west and southwest, ranches or homesteads are frequently remotely situated, while a large proportion of the population is found in isolated colonies or settlements. Schools have been established in all but the more sparsely settled sections, while the colonies generally have churches. The improvement of social conditions is, however, sometimes retarded by the diverse nationalities of the rural population and the inability of neighbors to speak a common language.

CHIEF TOWNS AND TRANSPORTATION.

The northeastern part of the area is well supplied with shipping facilities and means of communication afforded by the main and branch lines of the Great Northern and by the Minneapolis, St. Paul and Sault Ste. Marie railways.

Minot, having a population of some 7,500 and situated in the Mouse River Valley, in eastern Ward County, is the largest town of the area and an important railroad, milling, and shipping center. In the northwestern portion of the area, Williston, with a population of some 3,000, on the Missouri River and the Great Northern Railway, is the most important town and of considerable importance as a shipping point for grain and live stock. In Ward County, Kenmare; in Bottineau County, Westhope, Bottineau, Lansford, and Willow City, and in McHenry County, Towner, Balfour, and Velva are towns of considerable local importance as milling and grain-shipping centers, although there are but few of even the most modest railway stations in the eastern and better developed portions of the State without one or more grain elevators with accompanying facilities for marketing and shipping grain.

The more southern counties east of the Missouri River are fairly well supplied with shipping facilities furnished by the main line of the Northern Pacific Railway traversing Burleigh County, with the Linton branch, extending from McKenzie, in Burleigh County, to Linton, in Emmons County, and the Sykeston branch, traversing eastern McLean County, by the Linton branch of the Chicago, Milwaukee and St. Paul Railway, traversing southeastern Emmons County, and by the branches of the Minneapolis, St. Paul and Sault Ste. Marie Railway, traversing McLean, Burleigh, and Emmons counties. In some portions of this southeastern district of the area, however, the grain farmer must reckon with the necessity of making long hauls of a bulky product. Additional transportation is furnished between Washburn and a few of the minor upriver points by Missouri River steamboats. (Pl. B, fig. 2.) Bismarck, the seat of the capital of the State, is the largest town in this portion of the area and is something of a milling and grain-shipping center.

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In northern Morton County and in the more western counties, Stark and Billings, traversed by the main line of the Northern Pacific Railway, Mandan, followed by New Salem, Glen Ullin, Dickinson, and a number of smaller towns along the line, constitute the most important local centers and stock and grain-shipping points. Medora, on the Little Missouri River, in Billings County, lies outside the grain-producing districts, but is of some local importance as a shipping point for stock.

Most of the towns and shipping points along the recently completed lines of the Chicago, Milwaukee and St. Paul Railway, in Bowman and Adams counties, are new. The larger and more important of these are Lemmon, Hettinger, Bowman, and Marmarth.

Some of the counties of the west and the southwest are entirely without railroads or towns of any importance. In such cases the raising of live stock, which can be driven to market, is about the only industry open to the home builder. The construction of additional branch railway lines, several of which are projected, will greatly extend the agricultural possibilities of these sections of the survey.

Rural post-offices and local stores are scattered throughout the area, but in the more sparsely settled districts the farmers are remote from railroads or from towns at which supplies may be purchased or an outlet for produce may be obtained, necessitating long hauls, requiring one or two or more days for the trip.

Rural mail delivery service has been established in many of the more thickly settled communities, while telephone communication is had between the farms, ranches, and settlements in many parts of the area. In the older settled prairie districts the roads are easily constructed and maintained and are of excellent character, but where broken by deep ravines or stream valleys they are often marked by heavy grades. In the broken or "Bad Land" areas, the stream courses are usually unbridged, and the roads are few and often impassable for loaded vehicles.

The principal products, consisting of grains and live stock, are marketed in the cities of the Middle West, although a small proportion of the wheat produced is ground in the local mills. Grains are generally marketed at the elevators maintained by several competing companies, from which the product is usually shipped to Minneapolis or Duluth. Live stock, of which large shipments are made from Williston, Williams County; Plaza, Ward County; Dickinson, Stark County; Wibaux, Mont., on the Northern Pacific Railway, and near the North Dakota-Montana state line, and from many other points, usually goes to Chicago or to St. Paul, and occasionally to Sioux City, Iowa, the rate for cattle to Chicago being quoted at about $140 per car or $7 per head.

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FIG. 1.—A NEW TOWN IN THE PRAIRIE.

[In founding a new town, one or more grain elevators are usually among the first buildings erected.]

FIG. 2.—IMPROVED FARM IN AN OLDER SETTLED SECTION (MCHENRY COUNTY), SHOWING THE BETTER CLASS OF FARM BUILDINGS. POTATOES IN THE MIDDLE DISTANCE.

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There is usually a good local market for horses and hay. Wool is disposed of to competitive buyers who ship to Chicago or St. Paul. In the towns of the area poultry and dairy products and vegetables are usually in demand.

CLIMATE.

The most striking and characteristic climatic features of the area with which this report deals and which is embraced within the climatic province of the semiarid Great Plains, are a restricted and variable annual precipitation, long severe winters, and a relatively brisk wind movement.

While there is frequently considerable local variation in rainfall, the climatic conditions over the western half of the State are at a given time generally quite uniform and are not greatly influenced by topographic features, there being no elevated mountains, extensive forested areas, or other factors greatly influencing precipitation, temperature, or the force or direction of the prevailing winds.

The average annual precipitation is rather limited for the successful production of crops under ordinary methods of farming. The distribution of the rainfall is, moreover, somewhat fickle, varying greatly from year to year. The greater proportion of the precipitation occurs during the summer months as heavy local showers, often accompanied by thunder and lightning. For Williston the Weather Bureau records exhibit an extreme variation in the total precipitation between the wettest and the driest observed years of 15.9 inches.

While the area under discussion lies in the path of most of the storms sweeping across the country from the Pacific coast, the air currents have been robbed of their moisture in crossing the slopes and crests of the elevated mountain chains to the westward. The general distribution of the rainfall, however, is such as to favor the growth and maturity of crops, the greater proportion of the rain falling during the growing season, with the maximum usually occurring in the four months, May to August, inclusive, and a moderate amount in the spring and fall months. Comparatively little precipitation takes place from November to February, inclusive.

The years of greatest rainfall are not always the most favorable years for the production of crops, the harvesting of a successful crop seeming to depend more upon the absence of hot, drying winds and upon the timeliness of the rainfall rather than upon the total amount precipitated.

The annual snowfall is generally subject to considerable variation, ranging from but a few inches to several feet. It is, however, generally of a dry character and is readily removed from the exposed prairie surface and slopes by winds, so that while collecting as deep

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drifts in coulées, railroad cuts, or in other depressions, the grazing of stock upon the exposed hillsides and slopes in the broken lands is usually not greatly interfered with. A light fall of snow may occur as early as the latter part of September or the first part of October, but it usually soon disappears and is followed by several weeks of "Indian summer" weather, characterized by warm, fair days and clear, frosty nights.

Hailstorms are of relatively frequent occurrence and are often very destructive, and the insuring of crops against damage by hail is a common practice. Hailstorms are, however, of local character, and while the destruction wrought to crops is often complete, it is confined to relatively narrow strips or to small spots, and but a very small proportion of the country is affected during any single season.

The winter season is long and generally marked by long periods of severe temperatures accompanying periods of clear, fair weather, and brought about by the slow progress of areas of high pressure following the track of the usual cyclonic storms. During such periods temperatures ranging well below zero generally prevail and extreme temperatures of from −30° to −40° F. are occasionally experienced.

Killing frosts may occur early in September, the average date of the first killing frost falling about the middle of this month.

While the winter season is protracted, with the advent of spring the advance of summer is rapid. The last killing frost is generally looked for from the middle to the latter part of May, but light frosts may occur in almost any month of the year. During the summer months the days sometimes become extremely warm, temperatures of 90° to 100° F. or even higher occasionally being reached. A maximum temperature of 114° has been recorded at Medora. The nights are, however, usually cool, for with the setting of the sun radiation takes place rapidly, and in the broken or "Bad Land" districts, where the highest temperatures are generally recorded, a variation of from 50° to 60° between the extreme temperatures of the day and night are sometimes experienced.

The following tables give the normal monthly, seasonal, and annual temperature and precipitation at Williston, Bismarck, and Dickinson:

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Normal monthly, seasonal, and annual temperature and precipitation.

AT WILLISTON.

Month.	Temperature.			Precipitation.			
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year.	Total amount for the wettest year.	Snow, average depth.
	°F.	°F.	°F.	Inches.	Inches.	Inches.	Inches.
December	14	59	−46	0.6	0.4	3.1	6.1
January	6	52	−49	.6	.1	.1	6.6
February	8	57	−46	.5	.1	.5	5.4
Winter	9	.....	.....	1.7	.6	3.7	18.1
March	22	72	−35	.7	.1	.2	6.8
April	43	92	− 4	1.3	1.3	.7	4.0
May	55	101	11	2.1	.1	4.0	1.6
Spring	40	.....	.....	4.1	1.5	4.9	12.4
June	63	107	30	3.6	1.0	5.5	.0
July	69	106	37	2.2	1.9	4.2	.0
August	67	107	34	1.7	1.1	2.4	.0
Summer	66	.....	.....	7.5	4.0	12.1	.0
September	56	100	17	.8	.5	1.0	T.
October	44	95	− 3	.9	.5	.9	2.2
November	25	69	−29	.6	.3	.7	6.9
Fall	42	.....	.....	2.3	1.3	2.6	9.1
Annual	39	107	−49	15.6	7.4	23.3	39.6

AT BISMARCK.

December	15	64	−38	0.7	0.7	0.9	4.8
January	7	52	−44	.7	.5	.8	5.4
February	9	64	−43	.6	1.5	1.4	4.9
Winter	10	.....	.....	2.0	2.7	3.1	15.1
March	22	72	−36	1.0	.6	3.3	7.7
April	43	90	− 3	2.2	.3	2.8	2.5
May	55	94	20	2.6	3.4	5.7	1.4
Spring	40	.....	.....	5.8	4.3	11.8	11.6
June	64	98	31	3.6	1.0	1.2	.0
July	70	106	32	2.6	2.0	1.5	.0
August	68	105	32	2.1	.5	6.6	.0
Summer	67	.....	.....	8.3	3.5	9.3	.0
September	57	102	10	1.0	.5	5.6	.0
October	44	89	− 2	1.1	T.	.3	.8
November	26	73	−28	.6	.2	.9	6.3
Fall	42	.....	.....	2.7	.7	6.8	7.1
Annual	40	106	−44	18.8	11.2	31.0	33.8

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Normal monthly, seasonal, and annual temperature and precipitation—Continued.

AT DICKINSON.

Month.	Temperature.			Precipitation.			
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year.	Total amount for the wettest year.	Snow, average depth.
	°F.	°F.	°F.	Inches.	Inches.	Inches.	Inches.
December	18	53	−35	0.6	1.1	0.2	4.3
January	11	56	−35	.3	.9	.9	3.4
February	12	56	−43	.6	T.	.6	4.0
Winter	14			1.5	2.0	1.7	11.7
March	23	71	−20	1.0	.6	1.0	6.0
April	43	92	− 3	1.6	.4	2.4	2.5
May	54	106	18	2.0	2.9	5.2	1.1
Spring	40			4.6	3.9	8.6	9.6
June	62	105	28	2.2	1.4	2.5	.0
July	69	108	29	2.1	1.9	1.6	.0
August	67	110	24	1.9	.5	.6	.0
Summer	66			6.2	3.8	4.7	.0
September	56	98	14	.9	1.6	.3	T.
October	44	89	− 5	.7	.4	.7	2.0
November	25	74	−23	.6	.0	2.6	5.5
Fall	42			2.2	2.0	3.6	7.5
Annual	40	110	−43	14.5	11.7	18.6	28.8

During periods of both extremely high and excessively low temperatures the relative humidity is low, and neither is the cold so acute nor the heat so oppressive as would be the case in the more humid regions. The occurrence of fogs is infrequent and is usually confined to local depressions or stream valleys.

During the summer the percentage of sunshine is high and a compensation for the short summer season is had in the long summer days of this latitude.

The wind movement is generally brisk and days of relatively high winds are not of infrequent occurrence, particularly during the winter and spring months. Gales of considerable severity often accompany the local thunderstorms of the summer months. While damage is sometimes caused by lodging of grains or to insecure farm buildings occupying exposed places, there is very seldom any widespread injury caused by destructive winds. During the summer months there are brief periods of hot, dry winds, causing excessive evaporation, and when these occur during periods of drought, sometimes injuring the growing crops. The western part of the area is sometimes visited during the winter months by the "Chinook" winds. These winds enter the State from eastern Montana. They are warm

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and dry and very effective in removing the snow and improving the grazing.

There is at the present time a popular belief that a permanent climatic change has taken place and that there will be no further repetition of successive seasons of unusual drought. This belief has but little foundation in fact. Occasional seasons of limited rainfall accompanied by hot, drying winds may be expected to recur. The climatic conditions in general, however, are healthful, and, with the adoption of the best methods of dry farming, favorable to the production of the more hardy and drought-resistant crops.

AGRICULTURE.

EARLY INDUSTRIES.

In western North Dakota the grazing of cattle and horses upon the public domain became an extensive industry at a comparatively early date. Attracted by the practically boundless prairie lands, providing during the summer excellent grazing and carpeted at the advent of winter with a short but nutritious covering of naturally cured grasses, the early ranchers settled along the sheltered valleys where water might be easily obtained.

While frequently the stock was turned out upon the range the year around without feed or shelter other than that provided by nature, the cutting of wild hay for use in tiding the stock through the worst winter weather became a common practice.

Although the industry was subject to occasional and extremely heavy losses to stock during blizzards and heavy snows, the profits in years of comparative freedom from loss were large and a considerable number engaged in this industry became wealthy.

From the more favored localities the ranching industry spread until it had covered practically the entire area surveyed. During the earlier days of the industry herds of many thousand cattle were ranged over extensive areas by a comparatively few companies. This was later followed by a period of settlement during which the small rancher, grazing from 200 to 600 head of cattle and horses, came in. The raising of stock on this more limited scale has become a profitable industry. In some cases range horses are the sole product of the ranch. The greatest development of ranching took place in the late seventies and early eighties. The first stock produced was descended from that introduced by the early settlers, but it has since been greatly improved.

At a later date sheep were introduced into the country and the production of sheep upon a commercial scale was taken up. Owing to the splendid natural grazing facilities, good water, and the comparatively light expense incident to ranching, this industry proved

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to be very profitable, except during occasional winters so severe as to cause the death of many animals.

While it is to the rancher that this country owes its early settlement, the development of the ranching industry resulted in the building of only a few isolated houses, gave employment to but comparatively few people, and, in such districts as are suited to crop production, did little to bring about a permanent development of the agriculture.

DEVELOPMENT.

During the development of the ranching industry the idea prevailed that owing to the limited rainfall any extensive production of crops without irrigation upon the prairie land was impracticable.

There were a few ranchers favorably situated along the stream bottoms that had for some time practiced a desultory irrigation of the valley lands. This was usually restricted to the flooding of the valley bottoms in order to hasten or insure the growth of wild hay. Even after experiments by a few of the more progressive settlers in the irrigation or dry-land cultivation of the small grains upon these valley lands had given good results, the ability of the upland prairies to produce crops was doubted. Early trials with cereals were made here with but little faith in their success, and sometimes resulted in partial or complete failure, owing to unusual drought, the use of varieties unadapted to the soil and climatic conditions, and to the crude cultural methods employed.

With demonstration that dry-farmed grain would succeed during seasons of average rainfall, a few of the ranchers, disheartened by unusually heavy losses in their herds, turned their attention to farming. The success attained by some of these became more widely known, and the more attractive lands in the eastern part of the area, where the rainfall is normally slightly heavier, were rapidly taken up by homesteaders.

Among the earlier of these settlements were those made by the German-Russians along the lower course of the Knife River and south of the Missouri River, in the vicinity of Manhaven. Some of these settlements date back nearly twenty years, and although arriving nearly destitute and suffering many hardships, the settlers have built up one of the most prosperous farming sections in the State.

Other comparatively early settled farming districts occur in the northeastern and southeastern portions of the area surveyed. In the counties of Bottineau, McHenry, and Ward occur some of the most extensive and highly improved of these districts, although here less than a decade ago the profitable production of crops was generally doubted.

From these eastern sections of the area the progress of settlement has drifted westward. In certain sections, owing to severe losses of

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stock and the desire of the older settlers to place the country on a more permanent basis, the homesteader has been made welcome. In the northwestern portion of the area, north of the Missouri River, farming has within the past four years almost entirely displaced the stock-raising industry, and practically all the desirable lands subject to homestead entry have been taken up within the last two years. Settlement is now making rapid inroads upon the more broken and less desirable lands lying south of the Missouri River. In the southwestern counties, while farming has been practiced in limited sections for a comparatively long time, recent settlement of the land adapted to farming has been brought about by the extension of the railroads. This has led to the practical exhaustion of desirable homestead lands in this section and to the encroachment of the homesteader upon the partly broken or broken lands of the "Bad Land" districts. The last few seasons have been generally favorable to crop production and, except in a few sections visited locally by hail, drought, or hot winds, the production of farm crops has met with fair success. No small part of the success of the older settlers has been due to the demand for hay and food supplies created by the inrush of more recent settlers, who must purchase pending the harvesting of their first crops. Many of the later arrivals have in turn reaped the benefits of a lively market for such staple products in the temporary camps engaged in the construction of railroads or other engineering enterprises. The undertaking of irrigation projects by the United States Reclamation Service is now giving opportunity for the development of a more intensive system of agriculture, with the production of the more valuable irrigated crops. These projects will be considered further under the chapter on Irrigation.

PRESENT STATUS.

Agriculture is still in its earlier stages of evolution; the principal crops are those that can be produced upon newly broken land by extensive methods of farming and intensive methods of cultivation, and special crops have as yet gained but little foothold. Wheat, flax, oats, barley, potatoes, and wild hay, and, to a limited extent, emmer, or speltz, and corn, are the principal products, with the wheat crop the most valuable product. During the period 1892 to 1906, inclusive, the acreage devoted to the production of wheat in North Dakota rose from 2,868,729 acres to 5,992,000 acres, giving a total production in the latter year of nearly 88,000,000 bushels.[a] This increase was due largely to the extension of agriculture into the western portion of the State.

[a] Wheat crops of the United States, 1866–1906, Bull. 57, Bureau of Statistics, U. S. Department of Agriculture.

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The yield of wheat within the area surveyed is subject to considerable variation, depending upon the soil and local climatic conditions. In local districts and under unusually favorable conditions a yield of from 35 to 40 bushels per acre is sometimes harvested. The average yield is, however, much lighter, the average yield per acre for the State during the fifteen-year period cited above being 12.6 bushels. A yield of from 12 to 15 bushels per acre is usually considered profitable. The recent introduction of the drought-resistant macaroni or durum wheat, which is produced extensively in many of the counties embraced within the survey, has led to an increase in the average yield per acre. The price paid for the durum wheat is generally a few cents a bushel less than for the native varieties. Of the other varieties grown, the Bluestem and the Red Fife lead.

All varieties give a berry of excellent quality, the grain being extremely hard and ranking high in the market grades. Winter wheat is not grown upon a commercial scale, although the introduction of hardy winter varieties is now being agitated.

Flax is grown extensively in all parts of the area covered by this survey, and has always been a favorite crop upon newly broken sod land. The crop is grown entirely for seed. The yields and profits obtained are fair in favorable seasons, the yield usually ranging from 7 or 8 to 10 bushels per acre, although 15 or 20 bushels is sometimes obtained. The crop is a shallow-rooted one, feeding near the surface, sometimes hastening the loss of soil moisture from the immediate soil surface and preventing decay of the sod. It is somewhat subject to drought and is usually considered as more or less exhaustive of the land.

Oats and emmer, locally known as speltz, are important crops in certain sections, and these products are in good demand for feed. The average yield of oats is 28 or 30 bushels per acre. The Silvermine, White Russian, and National are the leading varieties. The average yield of emmer is probably in the neighborhood of 20 to 25 bushels per acre.

Rye, barley, and millet are relatively unimportant crops, but are produced to a limited extent. Of barley the Six-rowed Beauty, Hollis, Beardless, and Two-rowed varieties are usually grown, the average yield ranging from 15 to 20 bushels per acre. The crop is utilized principally for fattening hogs. Rye is reported as producing an average yield of 10 to 12 bushels per acre.

The yield of the small-grain crops grown upon the newly broken sod is usually light, and frequently so for a few seasons following the first breaking, owing to the slow decomposition of the sod and the difficulty encountered in preparing the land properly. The average cost of production of the grain crop from breaking to thrashing is said to range from $7 to $8 an acre. While the value of the average

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crop does not net a great profit over this cost of production, with the employment of the usual extensive methods of farming, a fair profit can generally be reaped from the average homestead in favorable seasons.

Corn is grown to a considerable extent in certain sections of the area, particularly in the eastern and southern portions. It is sometimes planted upon the freshly upturned sod, but as it can not be cultivated owing to the condition of the surface, it usually makes a poor growth and is not generally favored as a sod crop. The production of corn is generally attended with considerable risk, owing to the frequent occurrence of early fall frosts with consequent failure of the grain to mature. When not injured by frost, 20 bushels per acre is usually considered a fair yield.

As a forage crop, corn can with ordinary care be depended upon to give a profitable return, and with the breeding up of hardy, early maturing varieties, it is probable that strains will eventually be obtained which will, in average seasons, mature grain in at least a portion of the counties surveyed. In a number of localities the selection and breeding up of the "native squaw corn" is meeting with promising results. In the vicinity of Butte, Oliver County, a variety, reported to have been bred from this parentage, is said to be excellently adapted to the soil and climatic conditions. It is said to be unusually resistant to drought and light frosts, to mature early, and to yield 40 bushels or more per acre.

The cutting of the wild prairie hay is quite extensively practiced. It is usually fed upon the farm or sold to supply partly the local demand. The yield ranges generally from one-fourth to one-half ton per acre. After a single cutting from two to three seasons must elapse before another crop can be obtained. The hay is cut with a mower supplied with an attachment which catches the hay as cut and carries it until deposited in windrows by the operator. This is rendered possible by the fact that the hay is cured naturally previously to cutting. The cost of cutting and stacking ranges from $2 to $3 a ton and the hay is valued in the local market at $4 to $6 a ton.

Timothy is grown to a limited extent, and the production of brome grass as a hay and forage crop has been tried upon a more or less experimental scale. The latter grass is fairly resistant to drought, but produces heavier yields upon the moister soils. It should be cut comparatively early, before the seeds mature.

Potatoes rank next to the grain and hay crops in importance. They are extensively grown in nearly all parts of the area, are of excellent quality, and yield well, sometimes 150 to 250 bushels or more to the acre. The average yield is, however, probably not in excess of 100 bushels per acre. Early Ohio, Blue Victor, and Early Rose are the favorite varieties. (Pl. D, fig. 2.)

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The adaptation of particular soils to particular or special crops has as yet been but little recognized, and the rotation of crops is scarcely practiced at all. Owing to the natural productiveness of the virgin soils and to the comparative freedom from weeds, insects, and plant diseases upon the newly broken prairie lands, the ill effects of consecutive production of the same crop upon the same land have not forced themselves on the attention of the farmer. In the older settled districts, however, some of the lands are beginning to show some deterioration in productiveness, and with the rapid increase of weed pests[a] the advantages of a rotation, including the production of some intertilled crop, are beginning to be appreciated.

Of fungous diseases affecting the staple crops, flax wilt and the rust and smut of the oat plant are probably the most common. The fields are usually inoculated with these diseases by the use of infected seed. As a remedy, treating the seed with a solution of formaldehyde at the rate of 1 pound of 40 per cent formaldehyde to 45 gallons of water is recommended.[b]

Commercial fertilizers are not used and are doubtless at present unnecessary in the production of the staple crops. The growing of leguminous or other crops as a means of soil improvement is not practiced. In some cases barnyard manure is applied to the fields, but to a great extent this material is allowed to go to waste, and in some of the foreign settlements no little proportion is sun dried and made to answer the purposes of a household fuel. More attention could well be given to keeping up the supply of organic matter in the soil by green manuring and applying to the land all animal wastes.

The agricultural methods in vogue are in general well suited to an extensive system of agriculture and are probably the best that can be expected under present conditions of agricultural development and with the limited number of crops. The products of the farm are such as can be cheaply and quickly secured and sold for ready money. The methods are, however, being outgrown in the older settled and more highly developed districts and must be superseded by those suited to a more conservative and intensive system of agriculture.

In an effort to secure crops from as great an area as possible, and as the work is crowded into a short season, the area farmed by the newer settlers is shallow plowed and otherwise hurriedly and poorly prepared, and the subsequent treatment of the seed bed or crop is often such as does not tend to insure maximum yields. It is reported that in some localities in the southern part of the area even a cursory plowing of the land is sometimes neglected for periods of three or four years, the seed being drilled in on the old stubble without any

[a] Bul. No. 80, North Dakota Exp. Sta., gives suggestions for checking the spread of weeds.

[b] Bul. No. 74, North Dakota Exp. Sta. Hints to Homesteaders.

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preparation whatever. By such treatment the moisture-holding capacity and general physical condition of the soil are impaired. Deeper plowing and better cultural methods are, however, being practiced more widely in the older settled sections.

Owing to the shortness of the spring season, plowing is generally done in the fall. Sod land is usually broken in the summer or fall. The fall-plowed land may or may not be disked or receive other cultivation before seeding in the spring. Wheat and rye are usually sown from early in April to the middle of May; oats and emmer are sometimes sown as late as the last of May or the first of June. Harvesting of these crops is generally begun about the middle of August and lasts until early in September. Barley is sown from the last of April to June 1, and is generally ready for harvest from August 5 to August 20. The date of planting of flax ranges from early in May to well into June, the crop being harvested from the middle of August to the last of September. Corn is generally planted from the middle of May to early in June, and when not retarded in its development by frost should reach maturity between the 10th and the 20th of September. Potatoes are usually planted in May and harvested from September 15 to October 15.

The practice of summer fallowing, while not general, has been recently introduced into some sections of the area, and is becoming more common. When accompanied by summer cultivation it tends to increase the moisture content of the soil and to kill troublesome weeds, and usually results in increased yields. The practice is an improvement on continuous cropping of the land to one crop, but, upon the other hand, a considerable proportion of the land lies idle, which in the case of the usual 160-acre homestead devoted to crops under an extensive system of agriculture and operated upon a narrow margin of profits seriously reduces the productive capacity of the farm. The new settler is sometimes poorly equipped with farming implements. Modern farm machinery is in use on all the farms, with the exception of some of the newer homesteads. Single and gang riding plows of the disk or moldboard type are in common use, as are improved harrows, seeders, harvesting machines, and thrashing machines. In harvesting grain, both the self-binder and the header are employed, but the former greatly predominates. In some sections large gang plows hauled by traction engines are in a measure displacing the lighter breaking plows drawn by teams of four to six horses. The cost of the average equipment for a 160-acre farm, including one walking and one gang plow, one disk harrow, and one spike-tooth harrow, drill, binder, mower, rake, wagon, and two sets of harness, will approximate $600.

Too frequently costly farm machinery is exposed to the elements the year around, causing a rapid depreciation in value, which is sel-

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dom considered and which has for its only excuse the relatively high cost of lumber for the construction of sheds.

Some difficulty has been experienced in securing efficient farm labor, wages being generally high and labor scarce, especially during the harvest season, when transient labor, coming to a great extent from the cities of the East, is depended upon to a great extent. Day wages are nearly always high, but farm labor by the month with board can be secured at more reasonable figures. In some sections, as in the foreign settlements, large families are the rule and but little outside labor is employed, all members of the family sharing in the labor of the field. Inrush of homesteaders, many of whom are compelled to obtain employment upon neighboring farms while proving up upon their claims, has relieved the situation in the more recently settled districts. The custom of exchanging labor during periods requiring extra hands is common in some places.

Since the most of the land farmed has been acquired by homestead entry, the average farm consists of 160 acres. Some of the more prosperous settlers have, however, purchased neighboring homesteads, and with the prevailing farm methods and crops the tendency, at least for a time, will probably be toward larger rather than toward smaller farms. An attempt to farm much less than 160 acres under present conditions can not in most sections of the area under discussion be recommended, and in the partly broken districts or those in which the less productive soils predominate a half section of land should, if properly managed, be more certainly productive of a substantial income than a smaller area.

Nearly all the cultivated land is tilled by the owners, the renting of farm land being a relatively infrequent practice.

The price of land varies according to location and improvements. In the more level, older settled, and better improved districts, from $30 to $50 an acre for good farming land at a moderate distance from towns and railroad facilities would not be considered high, and unimproved sod land may be obtained for $25 to $30 an acre. Less desirable land can be obtained at a much lower price. In the more sparsely settled districts good farming land, but with little or no improvements, can be purchased at $10 to $25 an acre, the lower figure applying to the lands more remotely situated from railroad lines. Irrigable lands are limited and confined to a few districts and are relatively costly, although they may be had at a reasonable figure, considering their greater productiveness. In the broken districts grazing lands can usually be purchased at from $2.50 to $8 or $10 an acre. Desirable railroad lands now being sold usually bring from $15 to $35 an acre.

Sections 16 and 36 of each township constitute reserve school lands held by the State. Such lands are sold at public auction under

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authority of the State board of education, a minimum price of $10 being established by law. Except in the older settled counties, comparatively little or none of this land has as yet been disposed of.

Under the semiarid conditions here encountered, in order to attain permanent success the farmer must adopt a carefully planned cropping system, involving the systematic rotation of crops, the selection and development of drought-resistant varieties, and, finally, the practice of such field operations as will tend to increase the capacity of the soils for water and to reduce loss through evaporation to a minimum. The annual rainfall, except during years of extremely low precipitation, is ample for the needs of all the crops produced were the loss of soil moisture prevented. Many of the failures to farm successfully the lands of this section have been due to the employment of methods suited only to more humid regions.

The deeper subsoils are practically devoid of capillary water, the soil moisture being confined to a relatively narrow zone near the surface. During the warm days of summer this supply is rapidly removed through evaporation, which is here greatly hastened by the dry, warm winds, unless the capillary pores, or minute spaces between the soil grains, be broken.

For maximum results the soil should first be sufficiently loose and friable to allow the ready percolation of the rains. The depth of the soil reservoir should be increased by means of deeper plowing. The subsoil plow, particularly upon the heavier soils, may be used sometimes with excellent results. This implement should be employed only during a favorable condition of the soil, i. e., when not so wet as to be sticky or so dry as to break up into clods. There should be no large air spaces left in the soil, as these tend to hasten the drying out of the soil, and breaking up the soil to an unusual depth should either be done in the fall, so that the soil may be settled during the winter, or it should be followed by the use of the subsurface packer, the corrugated roller or by ordinary roller, in which case the surface should be immediately harrowed.

Having established a condition favoring the collection in the soil of a maximum amount of the rain or melting snows, tillage during the remainder of the season should have for its object the prevention of the escape, through evaporation from the surface, of the soil moisture which has been stored. This is accomplished by maintaining as far as possible, by means of cultivation, a mulch of loose soil upon the immediate surface, thus breaking up the capillary pores and preventing the rise of moisture from below.

While heavy summer showers may replenish the supply of soil moisture, they tend to compact the surface soil and thus reestablish capillary connection with the moist subsoils. When land is fallowed or when the condition of the crop will permit, each rainfall

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should be followed as soon as possible by harrowing or other surface cultivation. Owing to this effect of hard driving rains, a summer shower often accomplishes much more harm than good. The moisture stored in the soil prior to planting is generally of more benefit to growing crops than the refreshing and seemingly beneficial local showers of the summer season.

Disking of stubble land as soon as cleared of a crop is sometimes practiced in other dry-farmed districts and should be followed with beneficial results in western North Dakota. This can be quickly and cheaply done, and it quite effectually checks the loss of soil moisture from the surface, from which, since it is now no longer protected by the crop, the loss is large. This treatment also renders the land more easily plowed at a later date.

For spring seeding fall plowing is generally recommended, leaving the ground rough during the winter, in which condition it is better suited to catch and retain the rain and snow. Some, however, favor spring plowing, since the ground is sometimes so dry in the fall that decomposition of the sod or stubble turned under is retarded. The sod or stubble on unplowed land also assists in holding the snow, which is more readily blown from the plowed surface. Deep plowing of heavy sod land at the first breaking is generally not recommended, since burying the sod at too great depths retards its decomposition. With the weathering and decomposition of the sod it is a good practice gradually to increase the depth of plowing each year until the depth desired is attained.

An advantage is gained in the production of intertillage crops, in that the surface crust can be frequently broken. This advantage is in a measure offset in the case of the small grains and crops of like habits, however, by the shading of the surface by the closely growing plants and the screening of the land from wind. Both these conditions tend to check surface evaporation. If grain crops be harrowed lightly with the spike-tooth harrow, having the teeth set at a slant, or with the weeder, after becoming well rooted, the value of the moisture conserved in ordinary seasons will generally more than offset the loss due to injury of the plants by the process.

By the practice of summer fallowing both the moisture content of the soil, if kept in a porous condition during the summer months, is increased and the growth of noxious weeds is materially checked. Mere leaving the land fallow without cultivation is, however, productive of little, if any, beneficial results. For reasons previously stated, the practice of summer fallowing can not always be afforded by the farmer with a limited amount of land at his disposal, and it would seem that a system of crop rotation, including the growing of some leguminous or cultivated crop, might be devised, which would to a great extent answer the purpose of the summer fallowing. Of

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the cultivated crops which may possibly be grown under such a system, potatoes and corn are suggested. At the North Dakota Experiment Station, at Fargo, practically as much wheat was grown in a four-year period, during which three crops of wheat were produced in rotation with one crop of corn, as was secured upon a similar plot with four consecutive crops of grain. If the corn crop be chosen, the smaller hardy varieties should be selected.

Another practice suggested is to defer the spring planting, which is frequently made so early that the seed fail to germinate until some time afterwards, to as late a date as practicable, meanwhile conserving the water from fall and winter precipitation by frequent surface tillage. This mulching of the surface should be continued until the soil has become warmed sufficiently to be in favorable condition for immediate germination of the seed. By the time the seed sprouts the summer rains should add to the already moist condition of the seed bed and the plants grow to maturity without a check in their development. The exact time of planting, however, must be chosen with due regard to the more or less unstable condition of precipitation and temperature conditions at this time of the year. In connection with seeding it may be well to suggest that greater care be given to the matter of the selection and cleaning of the seed, in order that weed seeds and immature or unprolific seeds be eliminated.

In the application of these principles of dry-land farming under semiarid conditions, however, no set rule can be universally applied. The methods employed and the general character of the preparation of the land and of its subsequent cultivation as a means of conserving moisture must be adjusted to suit varying local conditions of soil and climate. The most advantageous methods can often be established only after trial. While the maintenance of a loose condition of the soil surface is desirable not only during the period of growth of the crop, but after its removal, in order that the supply of moisture for a subsequent crop may be as great as possible, the practice of keeping the surface in the extremely fine condition of the dust mulch so often recommended as a means of preventing evaporation can not here be rigorously applied, owing to danger of drifting of the fine soil by the wind. Damage is likely to result from this cause, especially in the case of the lighter soils of the area, and it is not as necessary to stir the surface of these soils after rains, as they do not crust. Upon the other hand, where mulching is done in such cases the compacting of the soil by the use of the subsurface packer or roller is recommended.

The Canadian field pea is suggested as a leguminous crop which might well be worth trial. The peas make excellent food for fattening sheep and hogs. A good stand, it is claimed, should produce from 50 to 100 bushels per acre. Some trouble may be experienced

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from lodging of a heavy crop, but with the improved attachment for mowers but little trouble is now generally experienced in harvesting. The crop may be pastured if desired. Mixed with barley or oats, the peas may also be sown as a hay crop. Trials of the mixture of the field peas and oats are already reported as yielding from 3 to 7 tons per acre in North Dakota. The peas prove a most desirable crop in a rotation designed for improving the soil.

The growing of alfalfa is also to be greatly desired, not only as a valuable asset in a rotation with the cereal crops and as a soil improver, but as an adjunct in the production of dairy products, the feeding of live stock, and as a money crop. This crop has been grown locally for some time upon some of the inextensive irrigated lands of the stream valleys in the western part of the State, where it produces, under favorable conditions, two or three fair cuttings per season of about 3 tons total yield per acre. It has, however, been tried only experimentally upon the prairie lands, and in many cases such trials have resulted in failure or only in an indifferent success. It is said that this crop can not be successfully grown upon most of the prairie soils of the area without artificial inoculation of the soil. Since in most cases in which growing plants were examined the roots were found to be nearly or entirely without tubercles, some weight must be given this belief. Aside from the lack of bacteria, the soils are well adapted to the production of this plant. It is not unlikely that at least some of the difficulty experienced in growing alfalfa has been brought about by inefficient preparation of the land. The liberal use of stable manure is favorable to the inoculation of the soil and the development of the root tubercles.

The selection of a dry-land strain of alfalfa seed produced under conditions of soil and climate similar to those under which it is to be grown is also an important factor in the successful production of this crop upon the prairie soils of the area. In other western States alfalfa adapted to semiarid conditions is successfully grown without irrigation. In Idaho two crops per season are produced.

In Bulletin 62 of the Idaho experiment station, Dry Farming in Idaho, it is recommended that the crop be sown upon land summer-fallowed the year before, using seed at the rate of 4 to 8 pounds per acre if drilled and twice that amount if sown broadcast, and that the crop should be disked in the spring of the second year, having the disks set nearly straight. It would probably be advisable not to cut too closely during the first year's growth and to leave the foliage upon the ground as a mulch. The dry-land strains should reach full development the third season. For western North Dakota seeding during the latter part of the month of May is thought to be most favorable to the successful growing of the crop.

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From results of field examinations it is believed that the heavier loams of the northeastern counties of the area would prove excellently adapted to the production of the sugar beet. This should be demonstrated by experiments, and should these prove that the climatic conditions are suitable there is little reason why this industry should not be developed.

The growing of the sugar beet upon a commercial scale can not of course be made a success without the establishment of factories within a reasonable distance of the areas of production. At present there is no factory in the State. In some of the sugar-beet producing States, however, the feeding of the sugar beet to sheep or to other stock has at times been found more profitable even than the disposal of the crop at the factory, and it is believed the growing of limited quantities of this or of related root crops for such purposes in at least some of the counties of the western half of North Dakota could be made a profitable step in the rotation of cultivated crops with the cereals.

Vegetables are commonly grown for home use or for local market, the hardier vegetables, such as onions, cabbage, cauliflower, etc., producing good returns.

Tree fruits are but little grown and the few efforts in their production have resulted in indifferent success. The growing of small fruits, consisting of strawberries, bramble fruits, currants, etc., gives greater promise of success, although protection by heavy mulching during the winter is generally necessary.

In connection with the production of hay, root, and forage crops suggested, the production of a greater quantity of dairy products and the turning off annually of a limited number of head of fat stock could be practiced. This would open the way for a more diversified system of agriculture, lessen the risk of loss from unfavorable seasons encountered in the production of but a single or at most of but two or three cereal crops, and provide for soil improvement through the growing of leguminous crops, the return to the soil of the manure, the rotation of crops, and the practice of tillage operations resulting in better physical conditions of the soil.

The planting of groves and windbreaks, consisting mainly of cottonwood and box elder, about the buildings of the farm is quite common. The trees usually do well with a little care during the early period of growth, and the custom might well be extended.

CONDITION OF THE RANCHING INDUSTRY.

In North Dakota the laws in regard to fencing private lands are designed to protect the homesteader, who is not required to construct fences in order to protect his crops from the depredations of stock which may be grazing in the vicinity, and who, for any losses which

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may occur from trespass by such stock, may collect damages from the owner of the stock. Owing to this fact there has been developed within the area two antagonistic industries, represented by the rancher and by the homesteader. Before the advent of the homesteader the rancher made free use of the public range. With the coming of the homesteader his field of operations became limited, since he could rarely afford to maintain constant guard over his herds in order to prevent injury to the crops of the homesteaders who had perhaps taken up residence upon all sides.

While the rancher has in general looked upon the development of farming upon the arable lands as inevitable, and has in most cases displayed a spirit of fairness, the coming of the homesteader has not in all sections been welcome, for the rancher has been forced to retreat before advancing settlement, often at no little pecuniary loss.

This condition has brought about the decline of the ranching industry over nearly the entire area surveyed, with the exception of such sections as are not adapted to farming.

The ranching industry is now confined to those broken sections known as the "Bad Lands." Here most of the slopes and valleys support a fair growth of nutritious grasses, water is at hand, and during winter the snow is swept from the unprotected slopes by the wind, which exposes the dried grasses so that stock may get at them. In case of severe storms the stock may readily find shelter in the wooded stream bottoms and behind the protecting walls of the narrow ravines and coulées. The "Bad Land" sections, while valueless for farming and while supporting a less heavy growth of grasses than the level or rolling prairie lands, are thus eminently adapted to grazing, and usually are preferred by the rancher to the more open prairie lands. In these rough, broken districts and in a few other sections of the area, particularly within the confines of the Indian reservations, which are leased in large tracts for grazing purposes or to which grazing permits are issued for a consideration to owners of small herds, the grazing of live stock is still the leading and an important industry.

Ranching is accompanied with considerable risk, owing to the liability of sudden and severe blizzards of winter or heavy falls of snow. In case of the former the animals, if not protected, will often drift before the storm for many miles, which frequently results in the loss of many of the older or weaker members of the herds. In case of the deep snows the grazing lands are so covered that the animals are unable to procure food, unless provision for feeding them has been made.

Many have suffered severely from winter losses, and the practice of allowing the stock to rough it during the winter is less common than formerly. The more provident ranchers have during the last

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few seasons usually realized good profits, owing to prevailing good market prices for cattle and horses. Since the limit to which the stock may be ranged has suffered restriction through homesteading of the public lands, a greater amount of winter feeding has become necessary. In the case of cattle about 1 ton of hay for each head is considered adequate for one hundred days' feeding, or sufficient to carry each animal through the winter season. Prairie hay is, however, secured with greater difficulty each year, since the best hay lands have been secured by the homesteader, making further reduction in the size of the herds necessary.

Cattle are the most important product of the ranching industry, followed by sheep and horses. The size of the ranches and herds varies considerably, but the smaller ranch now predominates. Some of the ranchers own several thousand acres of land, while others lease the greater part of their grazing land.

Most of the range cattle are grades of the Hereford, Aberdeen-Angus, and Shorthorn breeds. The cattle are shipped to market in early fall without being grain fed, and many are sold to the farmers of the Central States as feeders. The importing of 2-year-old Texas steers to be finished on the range is quite frequently practiced, the cost of such animals ranging usually from $25 to $30 a head. These animals are generally expected to about double in value within two years. The most of the feeding is done during the months of January, February, and March. The cost of raising cattle with free range is estimated at about $4 per year. In the "Bad Lands" districts from 30 to 40 acres range per head per year is usually considered necessary, while upon the rolling or more heavily grassed prairie lands from 10 to 15 acres per head per year is considered sufficient.

Sheep rank next to cattle in importance, and there are a number of ranches in the area carrying from 2,000 to as many as 16,000 sheep each. The herds are split up into bunches of from 1,000 to 3,000 each and grazed over certain territory, each under the care of a herder and dog. The sheep are allowed to graze during the day and are bunched or corralled at night. In the aggregate a considerable number are lost through the depredations of wolves and coyotes, and during the severe storms of winter the loss of stock is sometimes excessive. Grazing is continued all winter, except during the most severe weather, when the flocks are kept in corrals and fed hay. From 40 to 60 acres of range per 100 head of sheep is usually required. In feeding during the winter from 1½ to 2½ tons of hay per day for each 100 head is usually considered sufficient for even the most severe winters. During some winters but little feeding is necessary. The sheep are mostly of the Rambouillet, Shropshire, Lincoln, Southdown or Merino blood, and grades of these various breeds.

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Of these the Shropshire is usually considered the most hardy. The cost of production is usually estimated at from 75 cents to $1 per head per year. The average annual wool clip per sheep is stated to be from 6 to 7 pounds for each full-grown animal, yearlings usually shearing from 5 to 5½ pounds. The price obtained for wool ranges from 15 to 20 cents a pound. A certain number of the sheep are marketed every year, the old ewes and wethers being shipped, a considerable number of which are sold as feeders, no sheep being fattened within the ranching districts.

Horses are raised in much the same manner as cattle and sheep, being allowed to graze the year around and fed with prairie hay only during the more severe winter weather. The cost of production of horses is usually very low, the principal cost being in obtaining desirable stallions.

The water supply in the ranching districts is obtained from the few rivers and creeks of perennial flow, and from springs, pools, or water holes in the beds of the larger streams of intermittent flow. In the principal grazing districts of the "Bad Lands" the water supply is obtained from the Little Missouri River and from intermittent tributaries of this stream. Except during the very driest seasons the water supply is sufficient for the range. Water of good quality may be obtained in the lower places by digging to a depth of from 5 to 30 feet.

In other portions of the area the question of water supply for stock sometimes becomes a more serious one, but in most districts water can be obtained at a moderate depth by sinking wells in the coulée bottoms, or reservoirs for storing the flood waters may often be constructed at the expense of a few days' labor in throwing earthen dams across some of these drainage ways.

Some of the well water of the area, and also that in many of the water holes, contains considerable quantities of alkali, but it is only in exceptional cases that the concentration becomes great enough to render the supply unserviceable for stock.

Among the native range grasses of value for grazing and for the production of wild prairie hay, the grama grass (*Bouteloua* sp.), western wheat grass (*Agropyron smithii*), prairie June grass (*Koeleria cristata*), buffalo grass (*Buchloe dactyloides*), sand grass (*Calamovilfa longifolia*), and the needle grass (*Stipa comata*) may be mentioned as of the most common occurrence and greatest importance. Of these the grama grass, buffalo grass, and the western wheat grass, commonly called "bluestem," are considered the most valuable for grazing purposes. The western wheat grass or "bluestem" is found principally upon the richer soils, where it soon crowds out all other grasses. The sand grass is usually found in areas where the subsoil is somewhat sandy.

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This grass, though it makes a luxuriant growth, is not very palatable to stock or very nutritious.

While the grazing capacity of the range has in some localities been severely taxed, an overgrazed condition is probably not as common as in many other of the western grazing States. It is possible that some improvement might be effected to native hay meadows by sowing timothy or red top or a mixture of these. A light harrowing of the hay stubble, followed by sowing before the first snows, has been found to produce conditions most favorable to germination in attempts to improve grazing lands elsewhere.

FUTURE OF THE GRAZING INDUSTRY.

It is probable that in relatively limited districts of the rougher, hilly portions of the area, as in the "Bad Lands" along the Little Missouri River and its tributaries, grazing will continue to be a permanent and the most important industry. The future development of the industry in these districts will likely be marked by the keeping of smaller herds and the production of improved grades of more carefully protected stock.

The ranching industry is, however, in imminent danger of still further curtailment. Even in the rougher "Bad Lands" districts, small areas of tillable land along the more gentle slopes and stream bottoms are found here and there, and with the exhaustion of the public lands in the more attractive districts and under stress of pressure exerted in the rush for free government homesteads, even the "Bad Lands" districts are now in places being invaded by the homesteader. In most cases only a small proportion of the land acquired can ever be profitably farmed. The greater proportion of each homestead is adapted only to grazing, and yet of insufficient extent to maintain enough stock to make this a profitable source of income. Under the prevailing climatic conditions, to attempt to provide for a family from the profits of production from the limited amounts of the ordinary hay or grain crops possible under these circumstances is, to say the least, a hazardous undertaking. While a few of the more frugal and industrious may succeed for a time, the total value of the resources developed by any extensive settlement would under the prevailing conditions undoubtedly fall far short of that produced in the normal course of the grazing industry which would be displaced.

The utilization of these small areas of arable land by those engaged in the stock-raising industry for the production of forage or rough fodder crops and grains such as kafir corn, millet, oats, etc., would, upon the other hand, constitute a valuable supplement to the range, in providing against loss during severe winters.

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The 160-acre homestead is, in these broken districts, usually insufficient to provide a working basis for the prosecution of either the farming or the grazing industries. It would appear that certain modifications in the present homestead laws, increasing the amount of land to which the homesteader may obtain patent in these more or less broken and untillable areas, would open the way for the development of a system of mixed farming and grazing under which a limited amount of stock could be grazed upon the more broken lands in connection with the production of hay, forage, and grain crops upon the tillable areas.

In some favorable portions of the area surveyed such a system has for some time been followed with generally good results. In some of the districts along the Missouri River, where this practice has prevailed, oats and hay have been the principal crops. These have been fed to cattle and the surplus sold at good profit.

PROBABLE TREND OF AGRICULTURE.

A gradual increase in the number of stock upon the farms in the older portions of the area may be looked for with the development of a more diversified system of agriculture. In some of these older settled farming districts at the present time the annual output of stock is said to compare favorably with the production for the same territory during the former ranching period.

The general crops during the past few seasons have been successful, and this has stimulated the development of agriculture and resulted in a rapid transition from grazing to farming.

Unfortunately many, particularly among the more recent settlers, encouraged by recent success, have gone heavily into debt and are staking their success upon the production of a single crop. These have assumed risks which, if continued, must sooner or later result in failure. However, while the recurrence of occasional dry seasons must be expected, unquestionably agriculture is capable of being permanently established over practically the entire area surveyed, with the exception of the more hilly and broken tracts, and the industrious and provident farmer who tills the soil with a view to conserving moisture, who diversifies his crops, and supplements agriculture with stock raising, will be able to suffer occasional unfavorable seasons and still reap a fair profit upon his investment.

SOILS.

The soils of the area fall into two grand groups, transported soils and residual soils, the material comprising the former having been transported from a greater or less distance by natural agencies, while the latter have been derived from the decay or weathering in place of the underlying rocks.

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Each of these main groups may be further subdivided into a number of natural subgroups according to the character of the material from which they have been derived and agencies controlling their mode of formation and subsequent modification.

Under each subgroup occur one or more soil types, or groups of types, each of which is represented upon the map accompanying this report by a distinct color.

In this preliminary survey a number of distinct soil types, which in the detailed soil surveys would be shown upon the maps in distinct colors, have been combined into a single class or group of types and represented by a single color. But little attempt was made to recognize either the smaller bodies of soils or the minor distinctions of texture such as demand representation upon the larger scale maps published in connection with the more detailed surveys. The grouping of types has been based upon similarity in origin, in agricultural value, and in importance for dry farming, the principal objects of this survey being to supply a demand for general information regarding the possibilities of dry-land farming and to delimit in a general way the areas suited to farming, mixed farming and grazing, and grazing alone.[a]

The soil types, or groups of types, shown by distinct colors in the map represent a number of soil series. A soil series consists of a number of types similar in general features of origin, mode of formation, and relation to agriculture, but differing essentially in texture or the relative amount of particles of different sizes of which they are composed. A complete soil series would thus consist of a number of soil types possessing like general features, but ranging in texture from coarse, gravelly material to heavy silts and clays. The general system of classification can be seen at a glance in the legend of the map.

In many cases the boundary lines separating the various soil types upon the map are necessarily arbitrary, there being more or less overlapping of the materials, one type merging into another by insensible degrees.

Since some of the types or groups of types represented upon the soil map embrace large areas where the soil material is similar but the topography, and consequently the adaptation to cultivation, vary widely, a land classification, showing the character of surface, has also been introduced. These differences are shown by different rulings in the group color.

The most of the soils of the area surveyed are marked by a relatively large amount of humus or organic matter, the accumulation of which is favored by the prevailing short summer season and mod-

[a] For a more detailed description of the soils and agricultural conditions in certain limited areas covered by the general survey, the reader is referred to reports upon the soil surveys of the Williston, McKenzie, and Morton areas.

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erate to low temperatures—conditions which retard the chemical and bacterial activities bringing about decomposition of vegetable matter. The proportion of organic matter of the soil is, however, subject to gradual decrease, corresponding to the decrease in precipitation from east to west across the area.

With the exception of a few types of limited extent and of those occupying the broken and hilly districts, the soils of the area are readily cultivated, and possess features of texture and structure which render them retentive of moisture and well fitted to respond to the methods used in other semiarid dry-farming districts.

A brief description of the principal features of the various soil groups, subdivisions, and series follows.

TRANSPORTED SOILS.

Transported soils cover considerably more than one-half of the entire area mapped, occurring over its northern and eastern portions. The soils of this group, except in the vicinity of the areas occupied by residual soils in which more or less intermingling of the material of the two groups has taken place, consist entirely of material carried to its present position and deposited by various agencies. Some of the transported soils owe their origin and formation to agencies which are actively engaged in transporting and depositing soil material at the present time, but the soils over by far the greater proportion of the area covered by transported soils owe their formation to forces which are here no longer active, and which operated under climatic conditions of a former period since profoundly altered.

The soils of this group, derived and transported from a more or less distant source, consist of several subdivisions, according to the character of the agencies of transportation and deposition. They will be discussed under the following heads: Soils of the glacial drift, which owe their origin to the soil-forming and transporting power of moving ice; soils of the glacial terraces, consisting of glacial débris and alluvial material deposited by ancient streams issuing from the glacier; soils of the glacial lakes, composed of reworked glacial detritus and sediments borne by former streams and deposited in the waters of ancient lakes; alluvial soils of more recent formation, occupying the present stream valleys and originating in the degradation of the land and the deposition of the material in favorable localities from running water; and æolian soils, or those owing their formation to the transporting power of winds.

SOILS OF THE GLACIAL DRIFT—WILLIAMS SERIES.

The glacial drift, which consists of material having a depth of from a few to more than 100 feet, within the area under discussion, gives

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rise to the soils of the Williams series, occupying the greater part of the northern and eastern two-thirds of the area surveyed.

The soils of the Williams series have been derived by the grinding and commingling of rocks and earth scraped from the surface by advancing glaciers. Much of the material, which consists of fine earth intermingled with rock fragments ranging in size from pebbles to huge bowlders, has been derived from the harder rocks far to the northeast of the district in which it has been deposited. With the advance of the glacier, slopes have been planed off, hills partially leveled, and the valleys filled with the detritus, and upon the final melting of the glacier the burden of fine earth, gravel, and bowlders borne within and upon the ice has been deposited as a mantle of drift over the altered land surface. Consequently, rounded or flattened gravel and bowlders worn smooth by the grinding action of the glacier are a characteristic feature of the soils of this series. While the material has in places been subjected to a rude assorting by glacial waters issuing from the melting ice, with the collection of sand, clay, silt, gravel, and bowlders in lenses or pockets, the material is generally unstratified, the mass being a heterogeneous mixture of earth and more or less worn rock fragments. Rounded and often scored and polished bowlders of the harder rocks, entirely unlike the rocks underlying the mantle of glacial drift, are scattered at intervals or occur in groups throughout the soil mass or upon its surface.

While the limit to which the ice extended during the Wisconsin stage of the Glacial period is marked by the great Altamont terminal moraine, the soils of the Williams series, derived from an earlier glacial drift, extend far to the south and west of this moraine and to some distance beyond the Missouri River. The occurrence of the earlier glacial till or drift, glacial valleys, and other characteristic ice-modified forms of landscape, and of glacial pebbles and glacial bowlders, give ample proof that this part of the area has been subjected to glacial action, but at an earlier time than the more northern section.

In the vicinity of the line of contact between the residual soils of the southwestern part of the State and the transported soils of the Williams series the older drift gradually thins out and there occurs a belt, usually several miles in width, over which the soils are composed of the two materials intermingled. Along the western and northern boundaries of the region covered by the residual soils of the Morton series the original drift has been largely or entirely eroded away, leaving only the rounded glacial pebbles and bowlders to indicate the former encroachment of the ice. Such rock fragments often rest directly upon the residual soils of the Morton series and are found for some distance beyond the boundary separating the transported and the residual soils.

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The soils of the Williams series are prevailingly of a dark-gray or light-brown to dark-brown color, generally underlain at from 8 to 12 inches by lighter brown subsoils, which usually grade quickly into light-gray or ashen or putty-colored calcareous subsoils of fine, often silty, texture, the proportion of lime being in some cases extremely high.

The calcareous material has been derived from the grinding and commingling of limestone rocks, and in places has been subject to further concentration by deposition from percolating waters, incrusting and more or less completely cementing the gravels sometimes found in the subsoil. While the lime content in the subsoils of this series is occasionally so excessive as to prove detrimental to the growth of the flax plant, it rarely causes unfavorable conditions for the production of other crops and is more frequently beneficial than otherwise.

The character of the surface is subject to great variation, the soils of this series occurring over the nearly level prairies of the ground moraine and the exceedingly hilly Coteau belt already described, and including partly broken and dissected land forms between these two extremes. Arrested or deficient drainage is a common feature of the soils, in common with all the soils of a morainic country not yet traversed by streams. In the vicinity of the infrequent stream valleys, however, the land surface is being dissected by tributary coulées and drainage established.

The soils of the Williams series are similar in general characteristics and may be considered the semiarid prototypes of the soils of the Marshall series, covering extensive areas of the more humid glaciated regions to the south and east of the area under discussion. The soils of the Williams series, however, differ primarily from those of the Marshall series in the lighter color of the soil and subsoil. They have been subject to less leaching and to the incorporation of less organic matter, owing principally to a more restricted rainfall.

Soils of this series have been of great importance in the development of both the ranching and the farming industries and where not too stony, poorly drained, or hilly or broken are well adapted to the production of dry-farmed crops.

Under the Williams series a number of soil types and groups have been mapped, which will be described individually in subsequent pages.

Soils of the Glacial Terraces—Williston Series.

The soils of the glacial terraces occupy areas of limited extent on the upper benches or terraces of valleys formerly traversed by streams of much greater volume than those occupying the most of these valleys at the present time. The soils of this subdivision belong to the Williston series, and owe their origin to the reworking

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and redeposition of glacial drift material. The deposits were at one time much more extensive than at present, the terraces having been subsequently eroded by the streams traversing the valleys. The soils of this series have been mapped under a single group of the Williston gravelly loams.

Soils of the Glacial Lakes—Fargo Series.

The lacustrine soils, embracing the soils of the Fargo series, occur throughout the glaciated portion of the State. In the hilly Coteau belt of the Altamont moraine small bodies of the soils of this series are as numerous as the lakes and ponds which occupy the hollows between the crests and slopes of the hills, but such areas are usually of too limited extent to be shown in the map. Farther to the north and east of the moraine, upon the plains and in that portion of the Mouse River Loop country formerly occupied by the waters of glacial Lake Souris, more extensive bodies occur, similar in origin and in essential features to the soils of the plains of the Red River Valley, in eastern North Dakota and western Minnesota, which mark the site of ancient glacial Lake Agassiz.

The more extensive soil bodies of the Fargo series owe their origin to the reworking of glacial detritus and the deposition of the sediments in the waters of glacial lakes by streams issuing from the glaciers. The smaller bodies of soil are often due to the filling of the small lakes and sloughs by sediments derived from the adjacent slopes and borne into the depressions by flood waters of heavy rains or by the wind, accompanied by the growth and decay of aquatic or semiaquatic grasses, sedges, or other vegetation, which has played an important rôle in the origin and modification of the Fargo soils.

The soils of the Fargo series consist of dark-colored to black surface soils, usually carrying a large percentage of organic matter, underlain by drab to dark-brown, nearly black, or mottled subsoils, rich in lime and frequently of a silty texture.

The soils of this series have in places been subjected to considerable modification, subsequent to their formation, by the action of wind and from the addition of recent sediments. Much of the coarser material occurring in the series within the area surveyed probably consists mainly of original glacial morainic material distributed by the waters of the former glacial Lake Souris.

Owing to the occurrence of these soils in nearly level, low-lying areas of deficient drainage, artificial drainage is frequently necessary to render them productive, and many of the less extensive areas are utilized only for grazing or for the production of wild hay. The more extensive and better drained bodies are, however, extremely productive and rank among the most valuable lands of the area surveyed.

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Alluvial Soils.

The alluvial soils found throughout the area in the stream valleys have been derived by erosion of the rocks and soils of the country traversed by the streams and their tributaries, transported by these streams, chiefly during periods of flood, and deposited from slack water on their flood plains.

Unlike the transported glacial drift and lacustrine soils, which owe their formation chiefly to agencies no longer active, the alluvial soils are of recent origin and the agencies forming them are still active in their formation. Small soil areas included with the alluvial soils are probably largely of material distributed by former glacial streams, and these would be recognized as members of the Williston series in the construction of a more detailed map.

The alluvial soils of western North Dakota are made up of two quite distinct groups or classes, viz, the alluvial soils of the Missouri River and its tributaries and the alluvial soils of the Mouse River Valley.

SOILS OF THE MISSOURI RIVER AND ITS TRIBUTARIES.

The soils along the Missouri River and its tributaries comprise members of the Laurel and of the Wade series. Several types in both of these series were recognized and described in detail in the reports upon the soil surveys of the Williston, McKenzie, and Morton areas.

Owing to the prevalence of easily eroded material over the drainage areas of the smaller streams and tributaries, the occurrence of torrential rains and limited amount of protecting vegetation and to the wide, shallow, shifting character of the larger streams vast quantities of sediments are being continually shifted, assorted, and deposited with every flood, filling some of the stream valleys to a great depth and causing frequent alteration or modification in the character of the deposits covering the lower slopes and terraces of the river flood plains.

The valley of the Missouri River is occupied chiefly by the soils of the Laurel series, consisting of light-gray to dark-colored sediments occupying nearly level or slightly sloping stream terraces and flood plains. Some of the material entering into the composition of the soils of this series has probably been transported from relatively great distances, while some is derived from the adjacent areas of the Morton and of the Williams soils.

The soils of the Wade series are derived mainly from material washed from the Morton soils and from erosion of the soft rocks outcropping along the streams traversing the eroded and dissected districts of the western part of the State. They occupy the small stream valleys tributary to the Missouri River.

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For the purposes of this general survey it was not thought advisable to attempt to separate the soils of these two series, the differences being those mainly of geological origin.

The soils of these two series, of which three groups of types were recognized and represented in the accompanying map, comprise the greater proportion of the alluvial soils of the area. The lower lying terraces are in many places heavily timbered with cottonwood, elm, box elder, ash, and other trees, or are covered with brush and wild roses. In the more westerly valleys a heavy growth of sage often occupies the upper terraces and valley slopes. The lower terraces sometimes have an irregular surface, owing to the occurrence of wind-blown sands or of remnants of former stream channels, or other marks of erosion. Although of limited extent, the soils in this group comprise practically the only irrigable lands of the area, and are, therefore, from an agricultural standpoint, of great importance. When not subject to overflow or excessively loose and porous in structure, they rank as productive and valuable farming lands, although in some of the smaller stream valleys, as along much of the course of the Little Missouri River, they often occur as small and frequently inaccessible bodies, and are generally utilized for grazing purposes.

SOILS OF THE MOUSE RIVER VALLEY.

The soils of the Mouse River Valley, with its tributary valley of the Des Lacs River, have been correlated with the soils of the Wabash series, previously encountered in extensive areas along the rivers of the middle western and southern States. Some of the material of the Mouse River Valley was undoubtedly deposited by former glacial streams traversing these valleys, and of much greater magnitude than those of the present Des Lacs and Mouse rivers.

The soils of the Wabash series consist of dark-colored sediments, usually high in organic matter and generally underlain by brown or yellowish brown subsoils. In the Mouse River Valley they are sometimes poorly drained and utilized chiefly for the production of wild hay, but when well drained are productive and well adapted to the small grains, hay, and hardy vegetables. Under this series two groups of types, the Wabash loams and the Wabash clay loam and clay, have been recognized and mapped.

ÆOLIAN SOILS—DUNESAND.

The æolian or wind-formed soil of the area consists of a single type (Dunesand) of no agricultural value save for grazing purposes.

RESIDUAL SOILS.

The residual soils are confined to the western and southwestern parts of the survey, lying west and south of the Missouri River,

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where they cover extensive areas. As previously noted, they are derived from the weathering of the rocks in place, consisting of shales, clays, sands, sandstones, and calcareous rocks, often separated by intermediate gradations between these various types of material and by seams and beds of lignite coal of from a few inches to several feet in thickness. These rocks underlie the entire western part of the State, but are, in the glaciated districts, deeply buried by the veneer of glacial drift, outcropping only where the surface has been deeply dissected by streams—as, for instance, at various points along the Missouri, Des Lacs, and Mouse River valleys. The rock strata lie in a nearly horizontal position and are of various colors, ranging through tints of brown, gray, drab, red, yellow, and white. They are quite easily eroded and belong to the Laramie series of the Cretaceous system.

In certain strata of this formation the presence of shales or of huge upright silicified stumps and of prostrate sections of tree trunks is a characteristic feature, while massive clay-ironstone and sandstone nodules and concretions of columnar, mushroomlike, or irregular, grotesque forms are often encountered.

Local areas, particularly in the vicinity of the Little Missouri River and its tributaries, are also marked by the occurrence of strata and surface outcrops of burned clays, generally of brilliant red hue, and often fused to a vitreous mass. The barren, red outcropping strata form conspicuous bands or caps marking the slopes or tops of the buttes. Frequently fragments of this scoriaceous material are scattered about the surface of considerable areas. They are commonly mistaken for rocks of volcanic origin. The fusing and baking of the clays and strata of interbedded material has been brought about by burning seams of lignite. In one locality near the Northern Pacific Railway, between the towns of Belfield and Medora, there is at the present time a seam which is known to have been burning for at least twenty-five years. As the fire slowly eats its way backward into the seam the overlying rocks and earth slump into the cavity and open up new cracks and fissures for the ingress of air, although the progress of the fire is extremely slow.

The residual soils of the western North Dakota area fall into two natural main subdivisions, according to the character of the parent rocks, viz, soils of the shale and sandstone districts, and soils of the limestone districts.

Soils of the Shale and Sandstone Districts—Morton Series.

The residual soils of the shale and sandstone districts belong to the Morton series. Several types and groups of types were recognized and mapped, all the types encountered having been previously rec-

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ognized and described in the several detailed soil surveys made within the limits of the area covered by the present survey.

The soils of this series have in places been more or less modified locally by surface washing, the result of heavy rains, and by the action of winds, and where bordered by the soils of the Williams series, certain groups of types are subject to great variation in topography, becoming where dissected by stream channels more or less broken and at times so excessively hilly and eroded as to be unadapted to cultivation. The marked differences in surface have been shown in the soil map by means of black hachures. Along the contact the Morton soils are modified by the addition of glacial material, the areas being marked by bowlders and cobbles.

The soils of the Morton series resemble in color, texture, and structure those of the adjacent Williams series, from which they are in places separable only by more or less arbitrary lines, and with which they form the most extensive and important areas of the semiarid upland prairies of this and adjacent States.

Soils of the Limestone Districts.

The residual soils derived primarily through weathering from the limestone strata of the Laramie series of rocks are confined to a single soil body, occupying the district covered by the Kildeer Mountains. As already stated in the general description of the area, these mountains are a remnant of a former more elevated plateau, rising to the height of some 500 feet above the general level of the adjacent plain and capped with strata of dolomitic limestone.

The residual soils derived from this material are represented by a single soil type, designated the Kildeer loam.

The following table gives the names of the several soils and the area which each covers:

Areas of different soils.

Soil.	Proportion of total area surveyed.	Area of soil type, group, or surface condition.	Total area of soil type or soil group.	Total area of soil series.
	Per cent.	*Acres.*	*Acres.*	*Acres.*
Williams stony loams	1.4	.....	345,600	
Williams gravelly loams	1.3	.....	329,472	
Williams sandy loams:				
Surface level to rolling	.8	188,928		
Surface hilly	.1	20,736		
			209,664	
Williams loams:				
Surface level to rolling	36.2	9,103,104		
Surface sharply rolling to hilly and broken	15.1	3,813,120		
Surface hilly and broken	1.9	488,448		
			13,404,672	
Williams clay loams and clay	.2	.....	57,600	
				14,347,005

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Areas of different soils—Continued.

Soil.	Proportion of total area surveyed.	Area of soil type, group, or surface conditions.	Total area of soil type or soil group.	Total area of soil series.
	Per cent.	*Acres.*	*Acres.*	*Acres.*
Morton stony loams	0.1	.....	11,520	
Morton sandy loams:				
Surface undulating to rolling	1.4	350,208		
Surface hilly	1.2	313,344		
Surface rough and broken	.3	69,120		
			732,672	
Morton loams:				
Surface undulating to rolling	17.5	4,391,424		
Surface sharply rolling to hilly or broken	3.4	852,480		
Surface hilly or broken	.8	191,232		
			5,435,136	
Morton clay and clay loam	1.7	.....	414,720	
				6,594,048
Rough broken land (Bad Lands)	7.8	.....	.....	1,960,704
Alluvial sands and sandy loams	.8	191,232		
Alluvial loams	3.8	972,288		
Alluvial clay loams and clays	.1	25,344		
			1,188,864	1,188,864
Fargo sands	1.2	311,040		
Fargo sandy loams	.6	154,368		
Fargo silt loam	.2	46,080		
Fargo clay loam and clay	.9	230,400		
			741,888	741,888
Wabash loams	.3	73,728		
Wabash clay loam and clay	.4	89,856		
			163,584	163,584
Kildeer loam	.2	46,080	.....	46,080
Williston gravelly loam	.2	41,472	.....	41,472
Dunesand	.1	29,952	.....	29,952
Total	.....	.....	.....	25,113,600

DESCRIPTION OF INDIVIDUAL SOIL TYPES AND TYPE GROUPS.

WILLIAMS STONY LOAM.

The areas of the Williams stony loam indicated upon the map accompanying this report include small bodies of the more valuable Williams loams of too small extent to be recognized upon the scale adopted for this survey.

The Williams stony loam consists of a brown or dark-brown loam, usually underlain by lighter colored—gray or yellowish gray—subsoil of slightly heavier texture than the soil. Mingled with this fine-earth material, which is similar to that forming the other loams of the series, is an excessive quantity of gravel and rounded or subangular bowlders, the proportion sometimes being so large as to render cultivation unprofitable or impractical without the removal of the stony material.

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This is a comparatively inextensive type, occurring only in a few bodies of irregular outline, mainly in the northwestern portion of the area surveyed, where it was first recognized in the detailed soil survey of the Williston area. Many areas of too limited extent to be shown upon the scale adopted in the reconnoissance but covering in the aggregate a considerable extent of country are, however, included with the Williams loams. In a detailed soil survey these would be shown as the Williams stony loam.

Areas of the Williams stony loam occur along rugged bluffs or irregular or eroded slopes bordering stream valleys in the overwash district, or upon ridges and hills covered by the coarser morainic débris in the Altamont moraine. The soil consists essentially of the coarser morainic material deposited within the area covered by this moraine or of glacial débris of an earlier date.

Owing to the steepness of the slopes, the rugged, stony character of the surface, and the excessive amount of gravel in the soils, but little of this type is at present under cultivation. It supports, however, a good growth of nutritious native grasses, and is used for grazing, to which it is well adapted.

WILLIAMS GRAVELLY LOAMS.

Under the head of the Williams gravelly loams are included the sandy loam and the lighter phases of the loam members of the Williams series carrying an excess of gravel in the soils and subsoils.

The soils consist generally of a dark-brown sandy loam or light loam, usually extending to a depth of from 10 inches to 3 feet. They are underlain by the characteristic light-gray subsoils of the Williams series. Soil and subsoil carry a relatively large proportion of gravel and cobbles, and the subsoil frequently grades into a mass of loose gravel or rounded or flattened cobbles, often incrusted with lime.

The Williams gravelly loams cover comparatively inextensive areas, the larger and most characteristic bodies occurring along the western slopes of the Altamont moraine and upon the flats and slopes in the overwash district. Other scattered bodies of more limited extent are found in the east-central part of the area surveyed, occupying flats and rolling valley plains, while in the vicinity of the Mouse River and the Des Lacs River valleys, and of a few intermittent stream valleys traversing the prairies, long, narrow bodies occur. These mark the edges of the upland plains or bluffs bordering the valleys, where the surface is more or less dissected by coulées and ravines.

The larger and more westerly areas owe their origin mainly to the deposition of the coarser material of the moraine and to its modification and concentration by former glacial streams of the overwash belt. The material deposited in this manner is similar to that forming the Williston gravelly loams, but, unlike the latter, they occur

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upon the upland plains and slopes rather than in stream valleys. The more easterly bodies owe their origin principally to the removal of the finer material by erosion, with consequent localization of the coarser material of the glacial till.

During the rainy months the Williams gravelly loams usually support a good growth of grasses suitable for grazing, but, owing to the broken character of the surface of the bodies in the vicinity of the Mouse River and the Des Lacs River valleys and to the loose, porous nature of the soils and subsoils of the larger bodies, it has generally a low value as farming land. Some of the more extensive areas in the vicinity of the morainic belt are used in the production of wheat and flax with fair results in favorable seasons, but cultivation of the soil is attended with considerable risk, owing to the liability of the crops to suffer in time of drought. The soil bodies mapped under this head include some small areas of the less gravelly Williams loams, which are well adapted to dry farming.

WILLIAMS SANDY LOAMS.

The soils classed as the Williams sandy loams consist chiefly of a friable and somewhat porous fine sandy loam of dark-brown color, containing here and there small amounts of gravel, usually extending to a depth of 12 or 15 inches. The surface material is underlain by a fine sandy loam similar to the soil in texture, but of a lighter shade of brown or gray. The group includes small areas of coarser sandy loam, which in a detailed survey would probably be recognized as a distinct type, and occasional limited stony areas or areas of light sand, mapped upon a large scale, would appear as the Williams stony loam and the Williams sand.

The Williams sandy loams group is not extensively developed, but several bodies of moderate extent and of irregular outline are found in the eastern and central portions of the survey. The largest areas are in southern Burleigh County. Other areas are shown in Emmons, Mercer, McLean, and McHenry counties.

The surface for the most part is gently sloping to rolling with occasional small areas where the wind has drifted the soil into low dunes.

The soil-forming material consists of the sandier parts of the glacial drift, derived largely, it is believed, through abrasion of sandstone ledges, and subsequently more or less modified by winds and by erosion.

The Williams sandy loams are well drained, easily cultivated, and free from alkali. They are, however, of a somewhat loose and porous character and when in a fine condition of tilth are subject to drifting, with possible injury to young plants. Owing to the same porous structure, the subsoils have rather low moisture-holding capacity, though, upon the other hand, give up the moisture readily to the

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growing plants. The loose surface soil has an advantage also in that it forms an ideal mulch which crusts very little after beating rains. The loss of moisture from the subsoil by evaporation can be reduced to a minimum by the use of the subsurface packer, followed by light harrowing.

Soils of this group can not be considered the equals of the heavier loam soils for dry farming, taking the average results for a period of years, but in favorable seasons excellent yields of wheat, flax, corn, and other crops of the area are secured. In fact, some of the most promising fields of wheat and flax noted during the progress of the survey were observed upon the Williams sandy loams. With intelligent cultivation and the practice of crop rotation, the most of the soil areas, except those having more open structure and those most exposed to the effect of winds, should be capable of profitable cultivation in average years, particularly if protected by wind-breaks. (Pl. E, fig. 1.)

The area of this group has been subdivided to show the different character of the surface, the more hilly bodies being shown by broken ruling of the body color selected to represent the group as a whole.

WILLIAMS LOAMS.

Under the Williams loams are included the loams, silt loams, and heavier phases of the fine sandy loam of this series, the last occurring, however, only to a limited extent. The areas represented upon the map include also local bodies of the Williams stony loam, the Williams gravelly loams, and the Fargo clay loam and clay, as well as occasional small bodies of the other soils of the Williams, Williston, and Morton series, all too limited in extent to be shown in a map upon the adopted scale.

The Williams loams are the most uniform and extensive soils encountered in the survey. They cover the greater portion of the northeastern two-thirds of the area. In general, the soil is a dark-brown or chocolate-colored loam or silt loam, from 8 to 24 inches in depth, underlain by light-gray or ash-colored calcareous subsoil. The immediate surface carries a relatively large proportion of organic matter, sufficient in places to impart a nearly black color to the soil, which gradually becomes less with increasing depth until the light-colored subsoil is reached.

Rounded or subangular pebbles, cobbles, or bowlders are of frequent occurrence in both soil and subsoil. These are usually composed of granite or other resistant rocks, although chips and fragments of limestone are not uncommon, particularly in the subsoils.

While of moderately heavy texture and compact structure the Williams loams are friable and easily cultivated and maintained in a good condition of tilth. They are sufficiently open to absorb readily

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the water from rains and snows, except upon the more abrupt slopes, and aside from occasional limited areas in which the gravel content is high have subsoils retentive of moisture.

Along the boundary between this group and other soils of the Williams series or other types or groups, the Williams loams are subject to more or less variation, as they generally merge by insensible degrees into the adjacent soils. Owing to this characteristic, while silt loams and loams constitute the bulk of the areas mapped as Williams loams, there are quite extensive areas, modified by the admixture of other soil materials, that depart more or less from the strict classification. In the vicinity of bodies of the Williams sandy loam and of Dunesand, the soil becomes lighter and more sandy and there is sometimes a belt several miles wide, where the soil is intermediate between the two groups. Such areas are most prominent around Drake in McHenry County, near Linton and Hazelton in Emmons County, southeast of Bismarck in Burleigh County, and in the lower part of the Knife River Valley in Mercer and Oliver counties.

Along the contact of the Williams loams and the residual soils of the Morton series, which region is marked by a gradual thinning out of the glacial drift material, the character of the subsoils is sometimes influenced by the underlying rocks and the residual soils derived from these rocks. Here the material included as Williams loams becomes more sandy where influenced by weathering of the underlying sandstone, or heavier in those sections underlain at shallow depths by clay and shale. Bodies showing the latter modification occur most frequently in the broken and hilly districts along the course of the Missouri River in the southeastern part of the survey. Except in the case of local areas in the Turtle Mountain district the soils of the Williams loams are treeless. They support a rich growth of prairie grasses valuable for grazing. They are subject to great variation in topography, ranging from the nearly level uniform prairies, such as occur in the northeastern half of Ward County, to the undulating and often rugged hill country of the Coteau belt and the rolling and dissected topography of the overwash belt to the southwest. The different types of surface are shown in the soil map by appropriate rulings.

The Williams loams are usually well drained and free from alkali, although marked by many small bodies of poorly drained soils belonging to the Fargo series. Where dissected by coulées or stream valleys, they are somewhat subject to erosion, but usually the soils are in their native condition well protected by sod. Under cultivation they are not subject to injury from gullying or washing, except along the more pronounced slopes.

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FIG. 1.—WHEAT ON THE SANDIER SOILS OF WILLIAMS SERIES, SHOWING CHARACTER OF CROP ON THE POROUS SANDY SOILS IN FAVORABLE SEASONS.

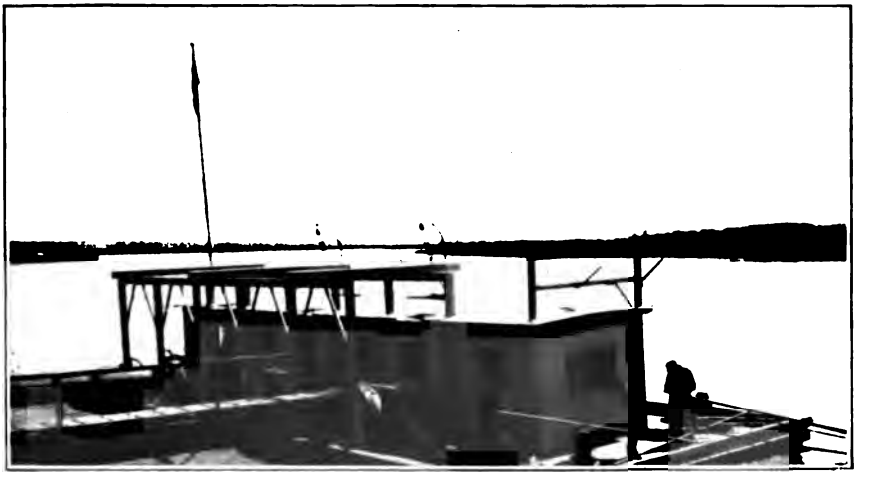

FIG. 2.—PUMPING BARGE OF THE U. S. RECLAMATION SERVICE, WILLISTON IRRIGATION PROJECT.

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Except in the case of the modified areas noted, the Williams loams are of glacial origin, being derived mainly from foreign material and consisting principally of the finer particles of the drift.

Much the greater part of the areas occupied by the Williams loams is level to rolling and, in general, excellently adapted to dry farming. In fact this group includes the best soils of the Williams series for the production of dry-farmed crops in average years. With the exception of the more abrupt slopes, the sharply rolling to hilly districts are generally capable of cultivation, but such bodies include local stony or eroded areas and the use of farm machinery is more or less restricted. For this reason much of the sharply rolling area is better adapted to grazing than to farming. The extremely hilly and broken districts are of limited extent and generally adapted only to grazing. Even here there are occasional small bodies of arable land. Different characters of surface have been shown in the map by distinctive rulings.

Wheat and flax are the principal crops, with potatoes, barley, oats, rye, and corn as subsidiary products.

WILLIAMS CLAY LOAM AND CLAY.

The Williams clay loam and clay group, as is indicated by the name, would be separated into two distinct types if mapped upon a more detailed scale.

The soil consists generally of a dark-brown or dark-gray heavy clay loam or clay, ranging from 8 to 15 inches in depth, underlain by a dark-gray, brown or dark-brown subsoil. In both soil and subsoil, glacial gravels and bowlders are of frequent occurrence. The soil has a rather compact structure and is less friable than the loams of the Williams series.

This group is of limited extent, and occurs only in the extreme northeastern part of the area, in the district covered by the Turtle Mountains. The surface is elevated several hundred feet above the level of the adjacent country, is rolling or hilly, and dotted with numerous glacial lakes. Unlike the other soils of the series, with the exception of very local areas of the Williams loams occurring in the same locality, the clay loam and clay are thickly wooded with a variety of trees, consisting chiefly of elm, poplar, ash, and other hardwoods, interspersed with a thick covering of wild rose, brambles, and brush. In this feature, and also in the character of the subsoil, the group differs materially from the other soils of the Williams series, but it is similar in origin, the soil in this case being derived from the bowlder clay, or heavier material of the glacial drift, which here covers the original sedimentary rocks of the Turtle Mountains to the depth of many feet.

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These soils are of a somewhat refractory nature, but when cleared of brush and timber are productive and well suited to growing the staple crops of the area.

WILLISTON GRAVELLY LOAMS.

The Williston gravelly loams occur only as a few elongated bodies of limited extent, the larger of which appear in the valleys of Muddy Creek in southern Williams, and of Shell Creek upon the Fort Berthold Indian Reservation, in northwestern McLean and southwestern Ward counties. Smaller and less important areas occur in the vicinity of the Missouri River near Bismarck, in Burleigh County, and Fort Yates, in Morton County.

The surface materials in this group consist of light grayish brown to brown, rather light textured sandy loam or fine sandy loam carrying an excessive quantity of rounded or flattened gravel, usually of small size. The content of clay is usually sufficient to give the soil a somewhat sticky character when wet. The surface material is underlain at an average depth of about 12 inches by a somewhat loose and incoherent sandy loam of lighter color than the soil, but which is subject to more or less variation in texture and structure, at times passing into beds of fine sand, or gravel, or upon the other hand merging into light colored heavier material of fine texture, similar to the subsoils of the Williams loams.

The soil areas of the Williston gravelly loams are made up mainly of the soil material mapped in the detailed soil survey of the Williston area as the Williston gravelly sandy loam, but they embrace as well small bodies of a less gravelly or nongravelly sandy loam mapped in the Williston area as Williston sandy loam, and more or less of the recent alluvial material classed in the detailed surveys as the Laurel series. These usually occur in areas too limited to warrant separation upon the scale adopted in the present survey. Areas of the Williston gravelly loams occur upon more or less elevated, sloping to gently rolling terraces, marking the site of former stream flood plains which have been subsequently entrenched and partially eroded away. The areas are in most cases sufficiently elevated above the present stream flood plains to be rarely if ever subject to overflow, and owing to the prevailing porous nature of the soils and subsoils, they are well drained and free from alkali, though sometimes somewhat leachy and subject to drought.

As previously stated, the soils of the Williston gravelly loams owe their origin to the deposition of glacial gravels and finer sediments by the swollen streams originating in the melting ice and traversing the overwash belt, of which only elevated remnants now remain, owing to later erosion of the material by the present streams.

While the Williston gravelly loams, owing to the open character of the soils and subsoils, are not able to withstand drought, in favorable

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seasons profitable yields of the staple grain crops are secured. Limited areas have recently been provided with irrigation under the Williston irrigation project. When irrigated these soils should produce good yields of alfalfa and other forage crops, grains, and vegetables.

FARGO SANDS.

The soils of the Fargo series grouped under the general head of sands consist of medium to fine sands, the latter, however, predominating. They occur only as a few areas of moderate extent, the more numerous and larger bodies appearing in McHenry County.

The soils are of loose, porous, and generally incoherent structure, of a yellowish to grayish color, and extend to the depth of several feet. In lower lying areas or those protected from the winds the soils become darker as a result of the incorporation of a greater quantity of organic matter. The areas are usually without gravel, and have a level or sloping to undulating surface, in most cases sparsely covered with vegetation. In places wind-drifted areas occur. Owing to the open structure the Fargo sands are well drained except where they merge with bodies of poorly drained Fargo sandy loams or other soil areas of deficient drainage.

The bulk of the material entering into the composition of the Fargo sands probably consists of the sandier particles of the glacial drift. It has, however, been subsequently reworked and distributed, largely as beach and shore deposits, by the waters of the glacial lakes, although other bodies are probably coarser reworked glacial sediments borne to the waters of the lakes by glacial streams and thrown down as offshore and delta deposits. Considerable recent modification of the material has taken place through the agency of the wind and the incorporation of organic matter.

Owing to the scanty growth of native vegetation, this group of soils does not possess great value for grazing, and because of its low power of retaining moisture it is generally adapted to the production of dry-farmed crops only in seasons of abundant rainfall.

FARGO SANDY LOAMS.

The soils classed as the Fargo sandy loams are prevailingly light, fine, sandy loam in texture, although a type of sandy loam of medium grade would probably be recognized in a more detailed survey. Local areas of other soils of the Fargo and of the Williams series are also included within the areas mapped.

Under this head are grouped friable and easily cultivated soils of light-brown to dark-brown color, the latter shade occurring in the lower lying and protected areas, in which a greater accumulation of organic matter has taken place. The surface material sometimes

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extends to the depth of several feet, but it is generally underlain, at depths ranging from 15 inches to 3 feet, by gray or light-gray fine sandy loam or silt loam.

Only a few relatively inextensive bodies are found, chiefly in Bottineau and in McHenry counties. These are level to slightly undulating, and sometimes include rather low and poorly drained flats and depressions.

The soil material is chiefly reworked sandy glacial drift, similar in origin and in process of formation to that composing the Fargo sands, though finer in texture. As in case of the latter group, the soils have been modified by distribution by wind and by incorporation of vegetable matter.

As a rule a fair growth of grasses suitable for grazing is found on the Fargo sandy loams and the group, though less retentive of moisture than the heavier loams of either the Fargo or the Williams series, is moderately well adapted to the production of dry-farmed crops in favorable seasons. They are more or less droughty and crops will not do as well as on the heavier soils during rainless periods.

FARGO SILT LOAM.

The Fargo silt loam, like the sands and sandy loams of this series, is confined to areas of limited extent in the northeastern portion of the area surveyed.

Typically, the surface soil is a silt loam of dark-gray to nearly black color, usually without gravel, of rather friable texture and easily cultivated. This material extends to a depth of 8 or 10 inches, where it is usually underlain by a silt loam of gray to light-gray color. As mapped, however, the type includes the heavier phases of the Fargo fine sandy loam, thus varying locally to a rather sandy texture in some parts of the area.

The Fargo silt loam is one of the less extensive types encountered during the progress of the survey, occurring only as two relatively small soil areas in Bottineau County and one small area in northern McHenry County. Occurring in the lower depressions formerly covered by the waters of glacial Lake Souris, the surface is nearly level to gently undulating. The sediments forming the soil of this type were originally deposited in this lake, though they have been modified since deposition through the agency of the wind and the accumulation of organic matter.

This soil is particularly retentive of moisture and, though covering but limited areas, it ranks high among the soils of the Fargo series in the production of dry-farmed crops. It is generally devoted to wheat and other grains, under favorable conditions producing unusually heavy yields.

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FARGO CLAY LOAM AND CLAY.

In the Fargo clay loam and clay group the two heaviest soils of the series have been combined. Of these, the clay greatly predominates, and even limited areas of clay loam included are of a heavy type, and in physical characteristics and relation to agriculture approach much more closely the clay than the loams of this series.

The soil is of dark-gray to black color, contains a relatively high percentage of organic matter, and is generally free from gravel. It is of close, dense structure, extremely compact and refractory, exceedingly sticky when wet, and baking and checking upon exposure to the sun. It resembles in general physical features the adobes of the Pacific coast. Owing to these characteristics it is cultivated with more or less difficulty and is generally capable of being placed in a favorable condition of tilth only during periods of favorable moisture content, which are frequently of brief duration. The surface soil extends to depths varying from 8 to 15 inches, where it is underlain by heavy clay loam or clay subsoils of dark-gray, bluish-black or mottled black and brown color.

The Fargo clay loam and clay group occurs in bodies of small or only moderate extent, the larger areas being found in the northeastern part of the area in Bottineau County. Areas are not confined to this part of the survey, but occur at intervals throughout its eastern third, the group being the most widespread of any of the Fargo soils. Many hundreds of bodies too small to be represented upon the map are scattered throughout the region covered by the glacial drift.

This group usually occupies low, flat, or but slightly sloping, depressed areas, which are in most cases poorly drained. They often collect and retain the drainage waters from higher lying lands, and there is not infrequently an accumulation of alkali salts in the soil. This is true particularly of the areas occurring within the hilly morainic districts of the survey. Here many of the smaller bodies are marshes, wild hay meadows or intermittent lakes.

The soils of this group have been formed by the deposition in glacial lakes of the finer sediments derived from glacial débris or from the weathered débris as found in adjacent soils. Such deposits have been in most cases sensibly modified since they were laid down, through incorporation of decayed tissues of aquatic or semiaquatic vegetation, which flourishes in these depressions.

Most of the areas mapped, owing to deficient drainage, are best adapted to grazing or to the production of wild hay, to which purposes they are in most cases devoted. Some of the more extensive areas in the northeastern part of the area mapped, in which the natural drainage is better, are used for farming and produce heavy

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yields of grains where carefully cultivated. Some of the heaviest yields obtained in the area have been secured from the soils mapped in this group.

With artificial drainage and thorough cultivation additional areas of the Fargo clay loam and clay of considerable extent in the aggregate could doubtless be profitably used for the staple hay and grain crops of the region.

ALLUVIAL SANDS AND SANDY LOAMS.

The alluvial sands and sandy loams of the Missouri River and its tributaries include all soils of a light sandy character of the Wade and the Laurel series occurring throughout the valleys of these streams. The group has a rather wide range in texture, comprising sands, fine sands, and the lighter phases of the sandy loams and fine sandy loams. Of these textures the fine sands and lighter phases of the fine sandy loams predominate. Owing to the generally complex manner of occurrence of the alluvial soils of the stream bottoms which are marked by intermingling of small areas of soils of the various textures and of frequent changes in texture and insensible gradations, the soils mapped in this group also include in the aggregate quite an extensive area of the heavier types of these series. The included areas are usually too limited in extent to be shown upon the scale used in this survey.

Usually the surface material is light gray to brown, although in places in which there has been an accumulation of organic matter the color is darker. It is generally of a loose, open, porous texture, easily cultivated, and in exposed places more or less subject to drifting.

The surface soils are of variable depth, extending to depths ranging from 8 inches to 3 feet. They are most commonly underlain by light-colored stratified deposits of sand, fine sand, or by beds of water-worn gravel, although subsoils of darker color and of heavier texture are frequently encountered. Gravel occurs in both soils and subsoils, the quantity sometimes being excessive.

Usually the sands and sandy loams of this group occupy the lower terraces and portions of the flood plains bordering the stream channels. In some cases comparatively extensive areas of the valley bottoms are occupied by them, and they prevail throughout the lower courses of the valleys of the Little Missouri and the Heart rivers and along the course of the Missouri River from Washburn throughout the southern half of the area surveyed. Along the more northerly and westerly course of the Missouri, however, this group is represented by a comparatively few inextensive areas, generally occupying only the lower terraces or occurring as narrow bodies bordering the stream channels. Here, owing to their limited development, they

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have been included with the alluvial loams or the alluvial clay loam and clay.

Bottom and terrace lands formed of the sands and sandy loams are frequently quite thickly covered with a growth of willow, cottonwood, or other timber and brush, and the lower lying bodies are occasionally subject to overflow during flood periods.

The soils of this group of types owe their formation to recent deposits of the coarser sediments of the flooded streams and the lower lying areas adjacent to stream channels are occasionally scored by wind or by stream erosion and are more or less subject to modification by the deposition of additional sediments during flood stages of the streams.

Owing to the prevailing loose porous character of the soil material, the soils when not subject to overflow are usually well drained and all but the heavier phases are of low moisture-holding power, and as they are not well adapted to the production of dry-farmed crops are chiefly used for grazing.

Under irrigation, however, and where not subject to overflow comparatively wide areas of these types could be profitably cultivated. They should prove to be well adapted to alfalfa, forage crops, and vegetables.

ALLUVIAL LOAMS.

The soils grouped and mapped under the head of the alluvial loams of the Missouri River and its tributaries consist of the Wade and the Laurel soils of loam and silt loam texture, and the heavier phases of soils of fine sandy loam texture.

Owing to the general complex manner of occurrence of the recent alluvial soils in small intermingled bodies, the individual types grouped under the alluvial loams are subject to wide local variation, and as mapped they include numerous small bodies of lighter, sandier soils, or of clay loam or clay, which, upon a more detailed map, would be shown as distinct types.

Typically the group consists of light-gray to dark-gray or dark-brown surface soils, from 6 to 18 inches in depth, underlain in the areas adjacent to the streams, particularly in the larger valleys, by a subsoil of sandy loam or fine sandy loam texture, and of light-brown or light-gray color. In other sections heavy silty loam or clay subsoils prevail over considerable areas, particularly in the case of bodies of the heavier phases of the loams. At a depth of from 20 inches to 3 feet the subsoil in many places grades into deposits of sands or light sandy loams. Both soil and subsoil occasionally carry gravel, and thin alternating layers and pockets of sand, sandy loam, silt, and clay. The soil is prevailingly of friable texture and is easily cultivated and maintained in a favorable condition of tilth.

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The alluvial loams of the Wade and Laurel series usually occur upon the higher or intermediate valley slopes and terraces, and are often separated from the immediate stream channels by low steep bluffs or by elongated areas of the sandier soils, though such is not universally the case. In certain parts of the valleys, the soils of this group cover the larger proportions of the valley lands, and they form the prevailing soils in the valley of the Missouri River throughout the western portion of the area surveyed. Other quite extensive areas of the loams of this group occur in the valley of the Yellowstone River in the extreme western portion of the area, in the valleys of the Knife River and its tributaries, and along the upper courses and tributary streams of the Heart and the Cannon Ball rivers.

The surface is mainly gently sloping and is subject to the occurrence of sandy ridges or of depressions marking the site of former stream channels. The lower lying bodies are sometimes subject to overflow during flood periods. Many of them are timbered with willow, cottonwood, boxelder, elm, or ash, or covered with brush and briers, but in some of the stream valleys there is no timber or at most only a narrow fringe of trees along the stream channels. In the more westerly valleys, as that of the Little Missouri River, the more elevated areas occurring upon the upper valley terraces are often covered with a heavy growth of sage brush.

In common with the other soils of the Wade and the Laurel series, the alluvial loams have been formed by the deposition of sediments from streams.

Soils of this type group are generally well drained, in fact they are sometimes droughty where loose, porous subsoils occur. When underlain by heavier subsoils they are well adapted to the production of dry-farmed crops.

Alluvial loams of the Wade and the Laurel series cover the greater proportion of the irrigable valley lands of the region, upon limited areas of which irrigation has been provided. Owing to the presence of timber or brush and occasionally to uneven surface, the expense of clearing and leveling for irrigation will in some cases be high. In bodies of irregular surface, care should be exercised in leveling, not to disturb deeply or to remove the surface soil when underlain at shallow depths by loose, porous subsoils, and thus expose the less productive material and increase the danger of loss of water by seepage through the porous subsoils, with consequent possible injury to lower lying lands.

Under irrigation the soils should prove excellently adapted to the production of alfalfa, forage, and truck crops, and they are likely eventually to become the most important soils of the area surveyed in the production of intensively cultivated, irrigated crops.

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ALLUVIAL CLAY LOAMS AND CLAYS.

The alluvial clay loam and clay group of the Missouri River and its tributaries embrace the heavier soils of the Laurel and the Wade series. Like the other soils of these series, however, they are subject to much variation, and the areas mapped include a greater or less extent of the lighter soils of these series. These included areas are too small to warrant separation in a reconnoissance survey.

The soils of this group consist usually of from 8 to 12 inches of heavy clay loam or silty clay loam of gray or light-brown to dark-brown or nearly black color, and of dense, compact structure. They are generally underlain by silt loam or clay of lighter color, but occasionally by a lighter, sandier material, and often pass into alternating layers of sand, silt, and clay at the depth of 3 feet or less.

Only a few small bodies of this group occur in the valleys of the Missouri and the Little Missouri rivers and of a few minor streams traversing the upland plains. The surface is flat or but slightly sloping and is often poorly drained and dotted with marshes, ponds, lakes, or sloughs, usually occupying former stream channels. The soil materials consist of the heavier sediments deposited by the streams in slack water or washed from adjacent outcrops of heavy clays or clay shales. Excessive quantities of alkali salts have accumulated in many places.

Owing to the limited area covered by these soils, and to their refractory character and poorly drained condition, they are of but little present agricultural importance. They are used solely for grazing, although if drained and irrigated the grain, hay, and forage crops of the region could doubtless be profitably grown.

WABASH LOAMS.

Under this head are grouped the various loam types of the Wabash series, consisting of the fine sandy loam, the loam, and the silt loam members. These usually occur in small and intermingled bodies, and sometimes include small areas of the heavier soils of the series, although not infrequently the soils are of moderately uniform character over quite extensive areas.

Typically the soils consist of dark-gray or dark-brown to black material usually of friable structure, extending to the depth of from 10 inches to 24 inches. Below this depth are commonly found a loam or clay loam of brown or mottled yellowish-brown color. The color change from soil to subsoil is, however, often gradual. Both soil and subsoil are subject to the occurrence of waterworn gravel and the subsoil sometimes gives way to beds of gravel and sand.

Comparatively inextensive areas of the Wabash loams are found. They occur upon the slopes and bottoms of the Des Lacs River

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Valley and that portion of the Mouse River Valley lying between Burlington, at the junction of the Mouse and Des Lacs rivers, and Villard post-office in central McHenry County. The surface of the areas are usually slightly sloping and they are generally well drained. In the vicinity of the stream channels they are often heavily wooded or covered with brush.

The soil material consists very largely of reworked glacial débris, derived from the adjacent areas of the Williams soils, deposited by the meandering streams. This overlies or in some instances has been intermingled with older sediments laid down by glacial rivers.

Generally the loams of the Wabash series are retentive of moisture and well adapted to dry farming. They are devoted partly to grazing and partly to the production of cereals, potatoes, and truck crops. The lighter and warmer loams of the group, where underlain by the heavier subsoils of high moisture-retaining capacity, are particularly well adapted to the growing of potatoes and hardy vegetables.

WABASH CLAY LOAM AND CLAY.

As the natural boundaries separating the group Wabash clay loam and clay from the lighter members of the series is more or less indefinite, the areas represented upon the map necessarily embrace small bodies of the Wabash loams. The surface material consists of heavy, tenacious, and relatively impervious soils, of dark-gray, dark-brown or black color. It usually contains a high percentage of organic matter and is of compact refractory structure, puddling when wet and baking and checking upon exposure to the sun. It is generally underlain at depths ranging from 8 to 15 inches by heavy, tenacious clay loam or clay of drab or dark-brown color.

Like the loams of the Wabash series the soils of this group occupy areas of limited extent, being confined to the valley of the Mouse River. Only two bodies of any considerable extent were encountered, one occupying the upper portion of the valley and extending down to its junction with the valley of the Des Lacs River, and the other, a more extensive area, covering the lower valley from a point near the center of McHenry County to the international boundary line.

The surface is level or gently sloping and the natural drainage is deficient, the bodies being crossed by sluggish streams bordered by trees, which in places give way to wide expanses of marsh land.

The Wabash clay loam and clay consist of the finer and heavier sediments deposited by the streams traversing the areas in which the soils occur.

Owing to the low-lying position and to the prevailing wet, heavy, refractory character of the soil, the Wabash clay loam and clay are

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not extensively cultivated, but are used for grazing and the production of native hay. When drained and properly cultivated, however, they are productive.

DUNESAND.

Dunesand is a nonagricultural soil, consisting within the area surveyed of loose, incoherent sand of light-gray color, fine to medium texture, and usually from 6 to 20 feet or more in depth.

It is confined to the eastern portions of the survey, where it occurs in bodies of elongated or irregular outline. The areas are most numerous in eastern McHenry County, but here they are relatively inextensive. A few bodies also appear in Burleigh County a short distance southeast of Bismarck, and small areas occur in the vicinity of the lower Knife River Valley.

Dunesand areas consist of prominent rounded or crescent-shaped hills or ridges, usually supporting only a scanty growth of grasses or shrubby bushes, although some areas of moderate size of well-grassed character sometimes occur.

Dunesand owes its formation to the transporting power of wind and is in most cases derived through the removal by the wind of sandy material from adjacent sandy soil types. It is valued only for the scanty pasturage it affords and is of no present value for cultivation.

MORTON STONY LOAM.

The Morton stony loam is subject to wide variation in the character of the soil material, the type being distinguished mainly by the abundance of stone, rather than by the texture of the interstitial material.

Generally the soil consists of a brown fine sandy loam or yellowish-brown loam of silty texture, extending to the depth of from 6 to 12 inches. The stone content, which ranges from 10 to 50 per cent of the soil mass, consists of gravel or angular rock fragments. The surface is frequently marked also by outcropping rock ledges. In the more southern and western parts of the district in which this type occurs the gravel and rock fragments are usually angular or subangular in outline and are most commonly sandstone or quartzite or cherty rocks with many fragments of silicified wood. In the vicinity of the areas covered by the soils of the Williams series a large proportion of the stony material is of rounded granitic glacial pebbles and bowlders. In either case the gravel and bowlders may occur embedded in the soil to the depth of several feet, or they may be confined mostly to the surface. The fragments range in size from small pebbles to large bowlders.

The Morton stony loam is one of the least important and extensive soils of the territory surveyed. Areas are scattered throughout the southwestern counties of the State, generally covering the slopes or

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summits of the hills and buttes. As typically developed, it owes its origin to the incomplete weathering of the underlying and outcropping rocks of the Laramie formation, the softer material being transformed to fine earth, while much of the harder ledges and cherty material associated with the softer rocks persist in the form of fragments of various sizes. The rounded fragments of granitic or other igneous rocks occurring in the vicinity of the glacial drift, however, which are intermingled with the fragments from the underlying rocks, are of glacial origin, having been derived from materials of the earlier glaciation.

The Morton stony loam usually supports a fair growth of native grasses, and, owing to the rough, rocky character of the slopes upon which it occurs and to the frequently thin and gravelly character of the soil material, it is generally used only for grazing.

MORTON SANDY LOAMS.

The Morton sandy loams consist for the most part of the Morton fine sandy loam, although the group includes considerable bodies of light and more or less loose and incoherent material which would in a detailed survey be recognized as Morton fine sand. Smaller bodies of stony or gravelly sandy loams of this series of too small extent to be separated are also grouped with the Morton sandy loams. The soils under this head frequently merge by indefinite gradation into the adjacent soils.

Owing to these characteristics the soils are subject to considerable variation in texture, structure, and in depth. The larger and most typical areas consist of a rather porous, friable, fine sandy loam of brown color, extending to the depth of 6 to 20 inches, with an average depth of about 9 inches. The surface material is generally underlain by a yellowish-gray or yellowish-brown fine sandy loam, frequently of silty texture and occasionally grading into silty loam at the depth of 3 feet or less. The lighter, sandier phases consist generally of light-brown fine sand or light, fine sandy loam, having a depth of from 5 to 10 inches and underlain by a gray or light-brown fine sand, often carrying a relatively high per cent of silt and grading into underlying loams of silty texture at a depth of from 3 to 5 feet. In places the subsoil passes directly into partially weathered sandstone rock at shallow depths. Both soil and subsoil are occasionally gravelly, carrying, in such cases, angular to subangular fragments of sandstone and chert.

This group of soils is found in numerous bodies scattered over the southwestern counties. Many of these areas are small, but others cover several townships.

The Morton sandy loams usually occupy undulating to rolling country. Sometimes the topography is broken as in portions of the

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upland plains covered by the residual soils derived from shale and sandstone. The bodies cover the slopes or tops of hills or buttes, occur as strips or bands following the trend of undulating ridges or as more extensive and uniform bodies forming undulating prairies. Usually the more elevated parts of the undulating prairies are occupied by the soils of this group, although bodies sometimes occur upon the lower flats or slopes. In some of the more broken prairie sections the slopes over limited areas become so steep and rough as to preclude cultivation. Such areas have been shown on the map by means of rulings.

In the vicinity of the higher dissected bodies the surface is occasionally broken by outcropping sandstone or cherty rocks. Excellent natural drainage and freedom from alkali salts result from the porous character of the soils and their elevated position.

In origin the soils of this group are residual, having resulted from the weathering in place of sandstone of the Laramie formation. They usually support a good growth of grasses of value for grazing purposes, although owing to the porous character of the soil, which renders it somewhat susceptible to drought, the native vegetation generally becomes somewhat thin during the later summer months, with consequent reduction in the grazing capacity of the land. During the early months of the spring and summer, however, the loose, porous soils of the slopes are more quickly warmed by the sun than the heavier adjacent soils, forcing the vegetation to an early growth and providing early feed for stock.

While the soils are of such character as to absorb readily the rains, there being but comparatively little run-off even upon the more pronounced slopes, the Morton sandy loams can hardly be said to be as well adapted to the production of dry-farmed crops as the heavier loam members of this series. The heavier phases of the sandy loams mapped under this head, in which the heavier silty subsoils closely approach the surface, however, possess features of texture and structure, rendering them more retentive of moisture, and under proper cultivation these soils are claimed to be nearly or quite the equal of the Morton loams in the production of dry-farmed crops.

Large areas are devoted only to grazing, but in the more thickly settled parts of the survey the level or sloping bodies are utilized in the production of the common staple crops of the region. Good yields of flax, oats, and potatoes are often secured, the yield of wheat, however, being generally somewhat below the normal for the area. In seasons of favorable rainfall the Morton sandy loams are particularly adapted to the production of potatoes and vegetables.

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MORTON LOAMS.

The soils combined under the type group Morton loams are comprised mainly by the loam and the silt loam members of this series. In addition limited areas of the heavier phases of the fine sandy loam and of the lighter, more friable phases of the clay loam members of the series are also included and mapped under this general head. Small bodies of the stony and gravelly loams of the series are also occasionally encountered. The soils are thus composite in character and subject to considerable variation in particular features of color, texture, and structure, although similar in general characteristics and in relation to crop production. Upon the other hand, extensive bodies of remarkable uniformity are sometimes encountered.

The most usual character of soil in this group is a brown loam carrying a small amount of fine sand or a brown silt loam. This surface material usually extends to the depth of 6 to 10 inches, where it rests generally on a yellowish-brown to light-gray loam or silt loam. In some cases the lower subsoil is a heavy, silty clay, while in other sections it is lighter in texture than the surface soil. The areas of heavier subsoils are of more frequent occurrence in the hilly or eroded districts, and those with lighter textured subsoils in the undulating prairie sections marked by sandstone ledges and by areas of the Morton sandy loams.

Over a few areas of considerable extent both the soil and subsoil are of a decidedly fine sandy nature, being influenced by adjacent areas of the Morton sandy loams or by the weathering of underlying sandstone strata. In such cases the proportion of fine sandy material in the soil is sensibly greater than the average, the soil becoming a light loam or a fine sandy loam. Prominent among bodies of such character are several occurring in the vicinity of Wade and in other portions of southern Morton County.

The soil is generally friable, moderately easy to cultivate, and readily maintained in a condition of tilth favoring the conservation of moisture. Both soils and subsoils are usually free from gravel or bowlders, except in the vicinity of areas of gravelly or stony loams.

The Morton loams constitute the prevailing soils of the Morton series and the most important soils for agricultural purposes of the southwestern portion of the area surveyed. They cover extensive areas, which are, however, broken by bodies of the other members of the Morton series. Like the Williams loams, the most of this group, which is derived from the weathering of the underlying shale and sandstone rocks, occurs over districts with several different types of topography. These differences have a critical bearing upon their agricultural value and adaptability to cultivation, and

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for that reason have been distinguished in the map by means of rulings. The greater proportion of the area covered consists of the undulating to gently rolling, elevated prairie plains of the Missouri Plateau. In such bodies outcropping rock ledges or steep slopes or bluffs are of only occasional occurrence, appearing in the vicinity of stream courses or of the smaller buttes of insufficient extent to be represented upon the map. The surface is usually free from bowlders in sufficient quantities to hinder cultivation, although near the line of contact with the Williams soils it shows some modification from the earlier glacial drift, and glacial pebbles and bowlders are not infrequent. With the exception of a few local areas, the Morton loams, with undulating to gently rolling topography, are easily cultivated. The surface permits the use of farm machinery, while of sufficient slope to provide adequate natural drainage with the loss of comparatively little water by run-off, except in the case of the heavier downpours. The soils usually support a good growth of nutritious native grasses, generally possess marked moisture-retaining properties, and under intelligent cultivation are well fitted to meet the requirements imposed by a system of dry-land farming. Deeper plowing and more thorough tillage should, however, prove productive of increased yields in the staple crops grown upon the soils of this type group.

In the case of the areas characterized by a sharply rolling to moderately hilly or broken topography the surface is more frequently marked by outcropping ledges, and gullied or eroded, and cut by stream valleys and marked by bluffs, hills, and buttes. Upon a considerable portion of the Morton loams of this type of topography, drainage is excessive, the soils are less retentive of moisture, and many of the slopes are sufficiently steep and rugged to render cultivation impossible or to prevent the use of farm machinery.

Land of this character is best adapted to a mixed system of farming, in which grazing has a prominent place. The hilly slopes support a good growth of grasses, and there are many running streams. The proportion of arable land is usually sufficient to make the production of field or forage crops the more important part of the farming operations. A greater area of land of this character will be generally required to make such a system sucessful than would be necessary in farming the less hilly and broken areas.

In those areas of the Morton loams indicated upon the soil map as of hilly or broken character, the greater proportion of the surface is broken by rock outcrop, deep and often narrow stream valleys, gullies, and by abrupt buttes and rugged hills. Land of this type of topography merges into the excessively drained and eroded districts mapped as Rough broken land (Bad Lands), and is adapted only to grazing. Any attempt to settle such districts with intent to

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produce farm crops, or to practice a mixed system of farming and grazing upon the basis of the 160-acre homestead tract, should be discouraged. Small areas of tillable land sometimes occur in these more broken and hilly districts, and can be made to produce a limited quantity of forage crops as an adjunct to stock production, but ordinarily the utilization of a tract several times the size of the present homestead will be necessary under such a system to give adequate returns for the labor and capital expended.

MORTON CLAY LOAM AND CLAY.

Under the head Morton clay loam and clay are grouped three individual soil types of the Morton series, previously recognized and described as the Morton clay loam, Morton clay, and the Morton gumbo in the reports on the soil surveys of the McKenzie and the Morton areas. In general these soils have similar textural, structural, and agricultural features, although they are subject to more or less variation in minor details. The areas mapped sometimes contain also local bodies of adjacent types of soils of insufficient extent to be separated.

The surface soil consists of a heavy clay loam or clay, usually of a decidedly silty texture, of dark-gray, brown, or dark-brown color, and extending to a depth of from 6 to 18 inches. The subsoils are generally of heavy silty clay loam or silty clay, of light-yellowish or grayish-brown to brown color, and usually extend to a depth of 3 or more feet, although they sometimes pass into the underlying partially weathered clay shale at shallower depths.

Frequently the immediate surface is a friable loam, but this is of shallow depth and in places has been removed from the slopes by erosion, exposing spots of the underlying heavy material. These spots are often barren of vegetation and of dense, compact, puddled unproductive character. They frequently carry an excess of alkali salts and are locally known as gumbo. The soil is usually remarkably impervious to water, which collects in poorly drained depressions as pools, where it may stand for weeks. When wet the material is extremely sticky and it bakes and checks upon subsequent exposure to the sun. The immediate surface in the gumbo spots is usually of somewhat heavier texture and denser structure than the underlying subsoils, although the heavier characteristics are to a great extent due to the puddled condition of the material. (Pl. F, fig. 2.)

Not in all cases are the soils and subsoils of this group of this refractory character, although they are generally compact and cultivated and maintained in a favorable condition of tilth with much more difficulty than the more friable loams of this series. Gravel, consisting of small, flat, shaly fragments, is of occasional occurrence throughout the soil profile.

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FIG. 1.—BAD LANDS DISTRICT.

[Cracking and sinking of the land surface is due to the burning seam of lignite coal. The burning of this material has contributed materially to the rough topography of these areas.]

FIG. 2.—BARREN "GUMBO" SPOT IN THE MORTON CLAY LOAM AND CLAY.

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The group covers much less extensive areas than the loams. It occurs as numerous bodies of oval, elongated, or irregular outline, and of varying extent throughout the southwestern portion of the survey. In some parts of this section the bodies most frequently appear upon the slopes or summits of rolling hills, while in other cases they are confined to the lower flats, poorly drained depressions, or the valleys of intermittent streams.

The areas in the vicinity of or occupying stream valleys are sometimes of rugged, broken surface, and marked by steep and frequently barren slopes, and by the occurrence of narrow, vertical walled ravines and gullies. Such bodies, among which are several prominent bodies occurring in northwestern Morton County, are frequently locally known as "bad lands," and resemble in some respects the true "Bad Land" districts, into which they frequently merge.

Soils of the Morton clay loam and clay group have been formed mainly by the weathering in place of shale rock. This residual material has in many places been subject to more or less modification by washing from the hill slopes, resulting in the removal of some of the material to the lower flats and stream valleys. The heavier barren gumbo spots are frequently encountered along hill slopes in the immediate vicinity of outcropping ledges of lignite and argillaceous shales, from which the soil material has been derived.

Owing to the frequent occurrence of the barren spots the growth of prairie grasses is generally of a less luxuriant and extensive character than is the case with the previously described soils of the Morton series, and cultivation and production of dry-farmed crops is not generally favored owing to the dense, refractory, and frequently alkaline character of the soils. In moisture retaining properties they are usually inferior to the more readily tilled loams. Considerable areas of the more friable phases of the clay loam and clay are, however, under cultivation, and while inferior to the Morton loams in productiveness, fair yields of the staple crops can be grown in favorable seasons.

Areas subject to the occurrence of barren gumbo spots may be improved by incorporation of large quantities of barnyard manure and by deep plowing and thorough cultivation. In many cases persistent treatment of this kind will probably effect a permanent reclamation, although the spots remain unproductive sometimes for several seasons after the land is broken.

ROUGH BROKEN LAND (BAD LANDS).

Under the head of Rough broken land are included several or all of the soil types of the Morton series. The distinction of the Rough broken land from the other Morton groups is based upon physiographic

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and not upon soil differences. The group comprises the excessively eroded and dissected topography known locally as "Bad Lands." In these districts no attempt was made to differentiate between the various soils. The term "Bad Lands" was first applied by early French explorers. It refers, however, not to any intrinsic sterility of the land, but to the character of the surface, the term by which these broken hilly districts were known, meaning "bad lands to travel through." (Pl. F, figs. 1 and 2.)

The general character of these districts is that of a minutely dissected and intrenched upland plain, gashed with steep-sided valleys and gullies, interspersed with rounded or flat-topped buttes or hills. These districts have been previously described somewhat in detail under the preceding sections devoted to physiography and to the general discussion of the soils.

Rough broken land (Bad Lands) is most extensively and typically developed along the course of the Little Missouri River and its tributaries traversing the southwestern portion of the area surveyed. Less extensive bodies are of frequent occurrence in the districts covered by the higher buttes of the Missouri Plateau and along the courses of a number of the streams traversing the districts occupied by the residual Morton soils.

Land of this character, owing to the broken character of the surface and to the prevalence of rugged or barren rocky slopes, is unadapted to cultivation and suited only to grazing, although small bodies of arable land sometimes occur upon the flats or slopes of the stream valleys. Such areas where alkali salts are not present in injurious quantities may be used to produce a limited amount of forage crops to assist in wintering stock. These areas are of very limited extent, and the general utilization of the rough broken lands in any way except in rather extensive tracts for grazing should be discouraged.

At present these districts are highly esteemed by ranchmen because of the growth of nutritious grasses, the accessibility of water, and the protection afforded by the buttes and ravines from winter storms. The section at present forms the chief support of the grazing industry.

KILDEER LOAM.

The Kildeer loam, the only residual soil of the area surveyed, excepting the soils of the Morton series, consists typically of a dark-gray to dark-brown loam, varying from 10 to 20 inches in depth. This surface material is underlain by a yellowish-gray or light-brown loam, similar in color and texture to the typical subsoils of the Morton loams. The soil, however, carries a considerably greater amount of calcareous material than the Morton loams, is usually of darker

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color, and under similar conditions of cultivation is somewhat more productive.

The soil is of moderately loose, friable character and is readily maintained in a favorable state of tilth where the topography permits cultivation.

The Kildeer loam occurs in a single body of moderate extent, covering the elevated Kildeer Mountain district lying south and east of the Little Missouri River. It has been formed mainly through the weathering of limestone or shales that are more calcareous than the rocks giving rise to the Morton series of soils. The surface is sloping and in a portion of the area somewhat abrupt and broken. The summit of the hills is bordered by steep, rocky cliffs and steep slopes, and the more elevated parts of the type are generally too rough and rocky to admit of profitable cultivation. The lower slopes of more gradual incline and of less stony character, particularly upon the east and south sides of the mountain, have been under cultivation for some years.

Wheat, oats, and corn are the principal crops produced, good yields usually being obtained. The type is generally considered particularly well adapted to the production of corn, on account of comparative freedom from frost, which results from the moderate elevation of the area above the surrounding country.

Irrigation.

While irrigation has been practiced within the area surveyed for many years, it until recently has been more or less desultory, involving the infrequent application of flood waters stored by damming coulées in the prairie land or flooding the native hay lands by water from the larger streams at times when the streams were high. This has been done in some cases in order to comply with the regulations of the desert-land act; in others, to stimulate growth of native hay.

Owing to the relatively few perennial streams and to the lack of sites for storage reservoirs in the valleys of those of less constant flow, the irrigable areas are confined to the valley terraces and slopes of the larger streams and a few of their tributaries.

In but few such areas can the diversion and distribution of water by gravity be readily or economically effected, and pumping must generally be resorted to. In either case, the engineering difficulties and the cost are usually too great to be attempted by the farmer or rancher. Through the operations of the United States Reclamation Service, however, three extensive irrigation projects have already been entirely or nearly completed, and the irrigation of additional tracts is contemplated.

Public land under these projects is subject to usual homestead entry, except that the farm unit or amount of land to which title

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may be obtained may be reduced, at the discretion of the Secretary of the Interior, to such an area as is deemed sufficient, under prevailing conditions, to support a single family. Land already held in private ownership by actual residents will be provided with water, but not for irrigation of tracts in excess of 160 acres. Lands subject to entry under the reclamation act are also denied the usual commutation provisions of the homestead laws. While but comparatively little public land subject to entry remains under the projects now in operation or nearing completion, of which brief mention follows, limited areas of excess holdings are open to purchase at moderate prices.

The Williston project covers about 7,000 acres of the valley, bench, and terrace lands in the vicinity of Williston. These lands are located north of the Missouri River and extend into the valley of Little Muddy Creek. Water is procured from the Missouri River at Williston by electrically operated pumps installed upon a floating barge. (Pl. E, fig. 2.) After the sediment has been deposited in a settling basin, the water is distributed by gravity and by auxiliary pumping stations to the irrigated lands. Power is transmitted to the barge from a steam-operated plant burning lignite coal and situated a few miles above Williston in the valley of Little Muddy Creek.

Farm units under this project vary from 40 to 80 acres and where practicable a supplementary tract of grazing land has been included with the allotment. The cost of water, which is dependent upon the cost of construction of the irrigation works, has been fixed at $38 per acre. This must be returned to the Government in not less than 5 or more than 10 annual installments of not less than $3.80 each, in addition to which an annual charge of 70 cents per acre for operation and maintenance and of 50 cents per acre-foot of water delivered is imposed.

The Buford-Trenton project covers some 12,000 acres of the alluvial soils of the Missouri River lying along the north side of the valley a short distance east of the Montana state line and west of the Williston project. Farm units are limited to a minimum of 40 and a maximum of 80 acres of irrigable land, in addition to which a tract of grazing land is included where practicable, bringing the total to 120 or 160 acres.

The construction and operation of this system is similar to that of the Williston project. The cost of water and the maintenance and operation charges are the same.

The Lower Yellowstone project covers an area of 66,000 acres of alluvial bench lands lying in the lower Yellowstone Valley in eastern Montana and in western North Dakota. About one-third of this area lies within the State of North Dakota. Unlike the preceding

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projects, the water supply is diverted by gravity, the head gates being located on the Yellowstone River at a point near Glendive, Mont. It is expected that this project will be completed and opened during 1909. The cost of water has not as yet been determined. Upon the lands under these projects the production of alfalfa is expected to become a lucrative industry.[a]

Preliminary surveys have been made with a view to irrigating the extensive alluvial terrace and bench lands along the Missouri River in the vicinity of Nesson, in southeastern Williams County, and below the town of Washburn, in southern McLean County, and in Oliver and Burleigh counties. The water for these projects will be secured by pumping from the Missouri.

In addition to these more extensive systems, a considerable area can be irrigated by the construction of small private gravity or pumping systems upon favorably situated alluvial flats and by the storage of flood waters in conveniently located coulées in the plains.

The water of the larger streams is of excellent character. The water in wells in certain sections of the area sometimes carries an excess of alkali salts or is discolored by lignite or other carbonaceous material in the water-bearing strata.

Drainage and Alkali.

In the morainic districts and in the lower portions of the plains of the Mouse River loop, occupied by the soils of the Williams and Fargo series, a general condition of deficient drainage is found. Here there are numerous glacial lakes, meadows, and bodies of wet, poorly drained soils occupying the depressions between the ridges and morainic hills. These depressions are usually without outlet and collect the surface water and water reaching the surface through springs or seepage.

The drainage in these depressions varies with the amount of rainfall, and in periods of unusually heavy precipitation land normally capable of cultivation may be completely submerged or converted into marsh or meadow. On the other hand, in a series of dry years considerable areas may be used for cultivated crops.

Heavier members of the Fargo series, which normally occupy the beds of former glacial lakes, are particularly likely to show deficient drainage, and many areas can be utilized only for grazing tracts or the growing of wild hay. In many cases these conditions can not

[a] Additional information may be secured by addressing the U. S. Reclamation Service at Washington. Inquiries regarding the Williston project may be addressed to the Williston Water Users' Association, Williston, N. Dak., those concerning the Buford-Trenton project to the Buford-Trenton Water Users' Association, Buford, N. Dak., and those regarding the Lower Yellowstone project to the Lower Yellowstone Water Users' Association, Sidney, Mont.

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be remedied without the construction of deep cuts through adjacent slopes or ridges, or by pumping, both of which would usually prove too costly to be attempted with the present land values. Not infrequently, however, the removal of water from the more elevated portions of the depressed areas may be readily brought about by ditching or by laying tile drains, or both. There are occasional areas of some extent over which marked improvement in drainage conditions might be effected at comparatively light expense by opening outlets to neighboring streams.

Owing to the regular addition and evaporation of spring and seepage water carrying small amounts of soluble salts, a gradual accumulation of alkali normally takes place in the soil and water occupying the poorly drained depressions. In the more westerly portions of the hilly morainic belt the water of the lakes generally shows a higher concentration of the salts than in the eastern sections. During the late summer these lakes frequently become entirely dry, and their beds are marked by baked and sun-cracked mud, coated with deposits of glistening white alkali.

In the Mouse River loop section some of the cultivated soils formerly covered by glacial lakes show accumulations of alkali salts sufficient to affect the growth of crops, other deficiently drained districts of comparatively extensive area occur in which the accumulation of the alkali salts has become more or less acute, particularly in the vicinity of McKenzie and Long Lake, in southern Burleigh County, and locally in the vicinity of morainic lakes in McLean, Ward, and Williams counties.

To reclaim such lands thorough drainage is the first requisite. With this accomplished, nature would in time bring about a gradual leaching of the salts from the soil, though, were facilities at hand for flooding the surface, the process might be artificially hastened.

In addition to the poorly drained soils of the glacial depressions in the eastern and northeastern portions of the area surveyed, extensive areas of deficient drainage and of marshy character, which have been noted under description of the Wabash clay loam and clay, occur along the lower course of the Mouse River Valley. The soil of most of these areas is productive when well drained, and it could be reclaimed from its present condition by a comprehensive system of dredging, by straightening the stream channels, by diking, and by installing drains and ditches.

In the valleys occupied by the alluvial soils of the Missouri River and its tributaries there are occasional less extensive areas of poorly drained lands, sometimes containing alkali. These areas are usually of limited extent, occupied by low-lying, heavy soils, and marked by occasional sloughs or remnants of former drainage channels. Such areas may usually be improved by artificial drainage.

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In the southwestern portions of the area, covered by the bad-land districts and by the residual soils of the Morton series, the lakes, marshes, and meadows found in the northern and eastern counties of the survey are wanting, but small areas of deficient drainage, in which the soils have become impregnated with injurious alkali salts, are frequently encountered. These are usually found in areas of the gumbo soils, and the injurious salts have been derived through the weathering of the alkali-bearing Laramie shales. Marked improvement in the puddled condition of the soils and a gradual decrease in the amount of alkali would doubtless follow artificial drainage, and this should be provided where practicable, but the present earning capacity of the land would probably not warrant a considerable outlay for such purposes at the present time.

In the western portions of the area, where the shales outcrop, the chief cause for alarm from the accumulation of alkali lies in the presence of alkali springs and lines of seepage along the slopes and bases of the hills and bluffs and in the possibility of seepage from irrigated areas. These waters will have a tendency to overspread and saturate the lower-lying irrigable areas and to bring about a surface concentration of salts which may prohibit the production of crops.

Summary.

The area surveyed covers a little more than the western half of North Dakota. It includes portions of two physiographic provinces of the United States, viz, the Prairie Plains and the Missouri Plateau. The surface of the former is level to undulating, treeless, and nearly streamless; the latter varies in topography from the rough and broken Bad Lands to rolling and hilly prairie lands.

The northeastern part of the survey is drained by the Mouse River and the remainder by the Missouri and its tributaries.

The climate is semiarid, with long, cold winters, brisk wind movement, low humidity, and a large percentage of sunshiny days.

The population is almost entirely engaged in agricultural pursuits. It includes many immigrants from the Scandinavian countries and from Germany and Russia.

Desirable land subject to homestead entry is practically all exhausted. Comparatively extensive areas are unused and subject to purchase. Prices for available lands vary from $10 to $50 an acre.

The area is traversed by a number of railway lines; and steamboats ply the Missouri River.

Grazing of cattle and sheep is an important industry.

The principal crops, all of which are dry-farmed, are wheat, flax, oats, barley, potatoes, and wild hay. These crops are produced extensively with the aid of modern farm machinery.

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Labor is sometimes scarce and wages high, but the conditions have not so far been acute.

The encroachment of the homesteader on the open range has caused a decline in stock raising, but this will always persist and be profitable in the Bad Lands, where ordinary farming can not be practiced.

In some sections, where arable and nonarable lands are found, a combination of crop and cattle production will be the best system of farming, but the ordinary homestead allotment of 160 acres will be insufficient to support a family.

A little irrigation is done by private enterprise. There are three important irrigation projects completed or in course of construction by the United States Reclamation Service, with others projected.

Under irrigation alfalfa, vegetables, and other special crops will be grown.

The more extensive soils are generally suitable for cultivation. They fall into two principal groups—transported soils and residual soils. The transported soils consist of the Williams series derived from the glacial drift, the Williston series (glacial terrace soils), the Fargo series (which come from deposits laid down in glacial lakes), the alluvial series Wade, Laurel, and Wabash (the first two formed along the Missouri, the last along the Mouse River), and, finally, the nonagricultural type Dunesand.

The residual group comprises the Morton soils, derived from shale and sandstone rocks, and the Kildeer loam, a type resulting from the weathering of limestone.

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SOIL SURVEY OF THE MODESTO-TURLOCK AREA, CALIFORNIA, WITH A BRIEF REPORT ON A RECONNAISSANCE SOIL SURVEY OF THE REGION EAST OF THE AREA.

By A. T. SWEET, J. F. WARNER, and L. C. HOLMES.

DESCRIPTION OF THE AREA.

The Modesto-Turlock area lies approximately in the center of the State of California from east to west and slightly north of the center from north to south. It is about 100 miles east of San Francisco, 300 miles north of Los Angeles, and near the center of the great valley which extends from northwest to southeast between the Sierra Nevada Mountains on the east and the Coast Range on the west. The upper part of this valley is drained to the south by the Sacramento River and the southern part is drained to the north by the San Joaquin River, the two uniting and emptying into Suisun Bay. Rising in the Sierra Nevada Mountains along the east side of this valley, flowing to the west and emptying into the San Joaquin, are three rivers of considerable importance, the Merced, the Tuolumne, and the Stanislaus. The Modesto-Turlock area lies on the east side of the San Joaquin and is drained

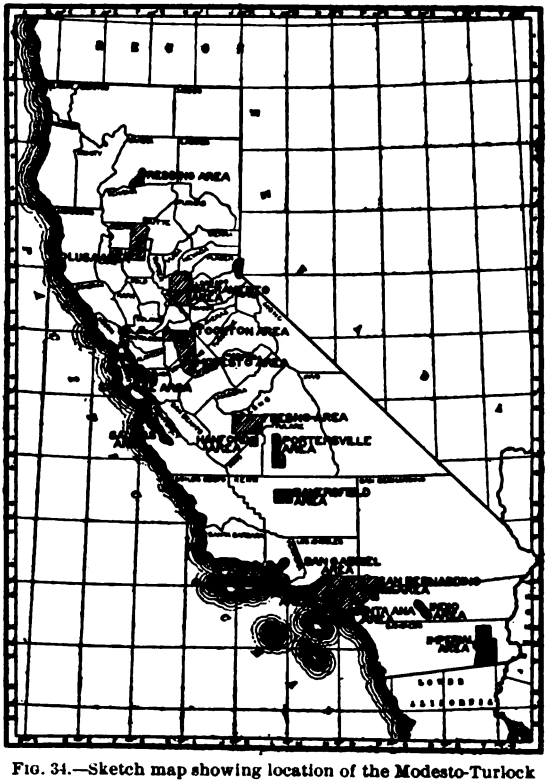

FIG. 34.—Sketch map showing location of the Modesto-Turlock area, California.

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and watered by these rivers, the Merced forming the southern boundary and the other two passing through it, the Tuolumne in the center and the Stanislaus in the northern part.

The area lies between the parallels of 37° 20′ and 38° north, thus having about the same latitude as southern Kansas, central Kentucky, and Richmond, Va. It covers a portion of three counties, San Joaquin County on the north, Stanislaus County in the center, and Merced County on the south. The area extends, from north to south, a distance of almost 40 miles and from the San Joaquin River east into the lower foothills, an average distance of almost 25 miles, the area actually surveyed being about 808 square miles.

For this work no satisfactory base maps were available, hence maps were constructed in the field for the entire area, except that portion occupied by the overflow lands along the San Joaquin River, a part of which, on account of high water, numerous sloughs, and cut-offs, was inaccessible at the time the survey was made. For this part of the area and the location of the San Joaquin River the county maps based on the Government surveys have been accepted.

Topographically the larger part of the area is a broad, almost level valley floor of slight but uniform slope from the low hills, into which the northeastern part merges, to the flat overflow lands along the San Joaquin River, but this plain is tilted very slightly to the west and northwest, so that the lowest part has an elevation of only about 20 feet above sea level, while the higher parts reach an elevation of almost 200 feet. Although young geologically this valley floor has been considerably modified by erosion. The higher parts along the eastern side have been dissected by many small streams and their tributaries, which carry the water of the rainy season, and have weathered into numerous hills so well rounded that all portions of them may be cultivated, while lower portions of the area along the San Joaquin River have been filled to some extent by deposits from this stream and its tributaries. In addition to these topographic features there are along the Tuolumne and Stanislaus rivers and also along Dry Creek abrupt bluffs and terraces which separate the present valley floor of these streams from the upland or old valley floor. These vary in height from 20 feet to 80 feet or more and are usually quite abrupt, showing outcrops of the underlying formations. In some places two and even three well-defined terraces mark former positions of the streams. These are especially noticeable along the valley of the Stanislaus southwest of Oakdale.

Another feature, not very conspicuous but of interest in connection with a study of the soils, is to be found in old overflow stream courses of the Stanislaus River, which are noticeable as broad, rather shallow depressions. One of these leaves the river at a point almost due

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north of Modesto and extends in a south and then westerly direction until after dividing into several parts it is lost in the lowlands along the San Joaquin, while on the opposite side of the Stanislaus a similar stream course leaves the river and extends due west to the San Joaquin. These old channels seem to indicate that at some time in its early history the main channel of the Stanislaus became choked at the point where the channels leave the river, causing its waters to spread out over the country on both sides. Still another of these old channels leaves the river on the north side near Oakdale and can be traced in a westerly direction beyond Escalon.

On the upland immediately south of the Stanislaus and Tuolumne rivers dunelike ridges of wind-blown sand occur. Extensive areas of this sand also occur south of Manteca and in the extreme southeastern part of the area.

The area is drained by the San Joaquin River and the tributaries above mentioned, each having small tributaries of its own, the largest of these minor streams being Dry Creek, a tributary of the Tuolumne, which drains a considerable area east of Modesto. A small portion of the northern part of the area is also drained by Little John Creek, which empties directly into the San Joaquin, but at a point outside of the area. A peculiar feature of the drainage is that it is well defined in the eastern part of the area among the foothills, numerous small streams having their sources there, but as these reach the more gentle slope of the valley floor proper they become less clearly defined, until they are almost or entirely lost, the water which they carry during the rainy season being absorbed by the soils of the lower part of the valley.

A rapid and marked change in the character of the population is taking place at present in parts of the Modesto-Turlock area. It is a change from a scattered population of grain growers to a dense population of dairymen, vineyardists, orchardists, truck and melon growers, and others who farm intensively; from a 1,000-acre[a] farm unit to one of 20 acres. This change is confined principally to those sections which have been brought under irrigation, but even those parts not yet irrigated have begun to feel the stimulus of the new order of things.

With the breaking up and marketing of the large grain ranches, on account of decreasing profits in grain farming and the introduction of irrigation, settlers have come in from all parts of the United States. In addition large numbers of foreigners are settling in the area. Of the foreign element, Swedes, Portuguese, and Italians predominate, the Italians being engaged almost exclusively in gardening, while

[a] The average size of the farms in Stanislaus County, as given by the United States Census for 1900, is 873.5 acres.

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the Portuguese have gained considerable reputation as successful growers of sweet potatoes.

Much of the contract labor, such as planting and caring for vineyards and picking fruit and berries, is done by Japanese.

Modesto, the county seat of Stanislaus County, situated near the center of the Modesto irrigation district and on the main line of the Southern Pacific Railroad, is a progressive town of about 3,500 inhabitants with all modern city improvements. A company has recently been formed and sufficient funds subscribed for the erection of a large canning factory. This will be of value to Modesto and the surrounding country. Oakdale, located in the northeastern part of the area, on the Stanislaus River, contains about 1,600 inhabitants and has good shipping facilities. Turlock, a town of about 800 population, is situated on the main line of the Southern Pacific system, near the center of the Turlock irrigation district. Ceres, Ripon, Manteca, and Escalon are small towns situated in the northern part of the area. Many other important towns and shipping points are scattered throughout the region.

Good shipping facilities are afforded a large part of the area by two lines of the Southern Pacific system and one of the Santa Fe, which pass through the central part of the area from northwest to southeast, thus connecting this section with both San Francisco and Los Angeles by direct line and furnishing shipping facilities to the East in either direction. The Sierra Railway affords means of shipping the products of a part of the area to the mines. The San Joaquin River has been used to some extent for shipping products grown along that river to San Francisco, Crows Landing being the principal shipping point.

One of the main hindrances to intensive farming has been the lack of suitable markets for perishable products, but with better railroad facilities, and with the building of canneries, packing houses, and wineries, much of this trouble will be overcome and products from the area will be put into such a form that they may be sent to the mines, to the East, or to foreign countries.

CLIMATE.

The climate of this section, like that of a large part of the interior valley, consists of two principal seasons—the winter, or rainy season, and the summer, or dry season. The former consists of rainy and foggy weather interspersed with clear, warm days, while the latter is noted for its cloudless skies and fresh, dry air. During the winter the weather is often damp and chilly, necessitating warm clothing and fires in the houses, but is rarely cold enough to interfere with out-

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door work. In fact, much of the plowing for grain and of ditching and leveling for irrigation is done during the winter months.

The fogs, which are at times so disagreeable, are of considerable value in furnishing moisture and in protecting olives, citrus fruits, and winter garden truck from frosts.

During the winter season on clear nights heavy frosts and even thin ice is not uncommon, but unless coming late in the spring little damage is done, except to unpicked fruit and to winter-grown vegetables.

No record of the occurrence of killing frosts within the area is obtainable, but damage to fruits, nuts, and vegetables from their occurrence between the first of February and the middle of April is not uncommon, the greatest damage usually being done in the lower valleys, which are more subject to frosts than the uplands. The lower portions of the uplands near the trough of the valley are also more subject to frosts than the higher portions.

The following tables of monthly and annual mean temperature and precipitation and the maximum and minimum temperature for the years 1904, 1905, 1906, and 1907 are compiled from the report of the United States Weather Bureau.

Normal monthly and annual temperature and precipitation.

Month.	Modesto.		Oakdale.	
	Temperature.	Precipitation.	Temperature.	Precipitation.
	°F.	In.	°F.	In.
January	46.6	1.84	45.7	3.17
February	50.1	1.20	48.7	1.82
March	55.9	1.37	52.7	2.37
April	62.2	.92	59.3	1.34
May	69.4	.47	64.9	.86
June	76.6	.10	73.9	.34
July	81.5	.01	79.7	.00
August	79.7	.00	76.3	.02
September	74.7	.19	71.4	.14
October	65.3	.56	62.5	1.14
November	55.8	1.43	52.9	2.00
December	48.1	1.85	44.9	2.23
Year	63.8	9.94	61.1	15.43

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Maximum and minimum temperatures for the years 1904 to 1907, inclusive.

	Modesto.								Oakdale.							
	Maximum.				Minimum.				Maximum.				Minimum.			
	1904.	1905.	1906.	1907.	1904.	1905.	1906.	1907.	1904.	1905.	1906.	1907.	1904.	1905.	1906.	1907.
January	71	70	81	79	32	38	34	30	71	65	63	62	26	29	26	26
February	75	84	85	79	34	35	40	43	67	72	71	66	28	25	38	32
March	75	86	84	79	40	44	45	40	74	77	72	73	32	31	34	30
April	87	92	89	90	41	49	53	55	87	81	83	82	40	42	33	45
May	108	100	86	94	50	49	52	60	101	98	88	95	46	44	45	48
June	104	99	102	98	55	60	53	69	103	98	101	99	58	50	53	43
July	106	110	109	98	68	60	70	82	105	114	110	101	57	57	60	60
August	108	105	106	101	60	60	60	89	108	107	107	103	57	55	56	55
September	108	104	102	104	56	59	60	80	107	100	97	95	52	48	52	48
October	98	102	106	90	41	45	47	50	89	94	92	88	40	38	34	48
November	89	90	89	70	44	39	34	38	77	75	73	76	32	30	24	31
December	78	84	84	60	36	30	33	38	62	58	62	68	27	21	20	29

During the winter months grass and alfalfa remain green and furnish much pasture, while vegetables are grown successfully in warm, sheltered places during the entire winter. In the summer the air is usually clear, dry, and invigorating, although at times quite hot, a temperature of 110° F. in the shade being not uncommon. Owing to the dryness of the air and the rapidity of evaporation, the heat is not oppressive like that of a humid region. The evenings are usually cool and pleasant. These long, dry summers furnish ideal conditions for the maturing and harvesting of fruits and other crops.

Records of rainfall have been kept by the station agents of the Southern Pacific Railroad, by grain dealers, and by others. Two of these—one from the Grange Company, giving the rainfall at Modesto for a period of twenty years, and the other from the Oakdale Milling Company, giving the record at Oakdale for a period of twenty-three years—are inserted. The rainfall in these tables is given by seasons rather than by years, since the crop for any year is dependent upon the seasonal rather than upon the annual rainfall.

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Rainfall at Modesto, 1888–1908—Record of the Grange Company.

Season.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	Total.
1888–89	.....	.....	.....	.....	3.26	1.42	0.28	0.38	2.22	0.22	1.39	.....	9.17
1889–90	.....	.....	.....	2.49	2.54	6.66	3.74	1.36	.23	1.48	.59	.....	19.09
1890–91	.....	.....	1.29	.....	.....	2.34	.27	2.66	1.03	1.10	.....	.....	8.69
1891–92	.....	.....	.38	.....	.12	4.06	2.63	1.77	2.21	.57	1.09	0.04	12.87
1892–93	.....	.....	.01	.89	3.70	2.20	1.68	1.83	3.18	.54	.21	.....	14.24
1893–94	.....	.....	.10	.....	.97	1.34	3.61	3.40	.09	.23	1.76	.57	12.07
1894–95	.....	.....	.....	1.73	.32	6.25	3.80	1.41	1.68	1.07	.35	.....	16.61
1895–96	.....	.....	.17	.07	.93	1.02	5.16	.07	.78	2.08	.29	.....	10.57
1896–97	0.30	0.02	.25	1.32	2.45	1.23	3.16	2.77	1.86	.14	.09	.02	13.61
1897–98	.....	.....	.....	.97	.18	1.17	.51	.69	.31	.12	.67	.....	4.62
1898–99	.....	.....	.28	.48	.33	.89	2.36	.12	3.39	.02	.94	.....	8.81
1899–1900	.....	.....	.....	1.89	2.88	1.29	1.31	.15	.88	1.73	1.47	.....	11.60
1900–1901	.....	.....	.14	.71	4.62	1.03	1.28	3.90	.35	.84	1.24	.....	14.11
1901–2	.....	.....	.05	.66	1.58	.65	.73	4.46	.65	1.06	.....	.....	9.84
1902–3	.....	.....	.....	.41	1.54	.59	2.19	.89	6.08	.32	.....	.....	12.02
1903–4	.....	.....	.....	.....	2.39	.17	.52	1.84	2.43	1.39	.09	.....	8.83
1904–5	.....	.13	2.57	.95	1.01	1.31	1.34	2.10	2.12	2.72	.....	.....	16.25
1905–6	.....	.....	.....	.....	.73	.93	2.56	2.50	6.17	1.50	1.14	.74	16.27
1906–7	.....	.....	.05	.....	.85	7.20	3.62	3.06	4.90	.11	.22	.54	20.55
1907–8	.03	.....	.....	.79	.04	2.14	3.70	1.13	.82	(a)	(a)	(a)	8.65
Average	.01	.007	.26	.66	1.52	2.19	2.32	1.82	2.06	.86	.57	.08	12.42

[a] No record after April 15.

Rainfall at Oakdale, 1885–1908—Record of the Oakdale Milling Company.

Season.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	June.	Total.
1885–86	.....	.....	1.13	6.54	1.26	3.61	.....	2.86	3.51	.....	.....	18.91
1886–87	.....	.....	.19	.95	.79	.48	3.14	.17	2.04	.....	.....	7.76
1887–88	.....	0.27	.....	.11	1.97	2.56	.47	2.21	.27	0.45	0.08	8.39
1888–89	.....	.73	.....	3.87	1.48	.37	.37	2.89	.27	1.58	.....	11.56
1889–90	.....	.....	2.48	3.20	6.65	3.51	1.47	1.06	1.74	1.67	.....	21.78
1890–91	0.10	1.12	.....	.....	2.56	.27	2.23	2.48	1.39	.06	.....	10.21
1891–92	.....	.14	.22	.28	4.54	.32	1.73	3.43	.73	1.26	.....	12.65
1892–93	.....	.18	.74	3.73	3.68	1.95	2.16	5.25	.66	.....	.....	18.35
1893–94	.....	.20	.....	1.42	1.63	5.34	4.94	.38	.90	2.46	.97	18.24
1894–95	.....	.35	1.15	.66	7.65	5.94	2.05	2.07	1.58	.50	.....	21.95
1895–96	.....	.22	.30	.99	1.34	5.46	.....	1.53	3.79	.65	.....	14.28
1896–97	.....	.....	1.70	3.04	1.86	2.76	6.73	2.83	.90	.08	.12	17.02
1897–98	.....	.23	1.56	.67	1.36	.78	1.33	.71	.16	1.47	.....	8.27
1898–99	.....	.44	.97	.44	1.67	2.61	.10	4.99	.16	.56	1.00	12.94
1899–1900	.05	.....	2.90	3.20	1.99	1.46	.51	2.17	2.93	1.50	.....	16.67
1900–1901	.....	.....	.94	5.79	1.15	1.83	5.45	.38	1.30	.76	.....	17.60
1901–2	.....	.62	1.09	2.74	1.13½	.88½	4.69	1.33	.91	.67	.07	14.14
1902–3	.....	.....	1.33	2.60	.82	3.61	1.02	6.66	.53	.....	.....	16.57
1903–4	.....	.....	.....	3.36	.49	.83	5.38	3.91	1.75	.13	.....	15.85
1904–5	.06	1.71	1.44	1.16	1.83	3.64	1.44	2.83	1.04	2.63	.....	17.78
1905–6	.....	.....	.....	1.10	.96	5.26	4.06	8.13	2.21	2.15	.09	23.96
1906–7	.....	.07	.....	.75	9.09	4.51	2.83	7.18	.18	.10	.65	25.36
1907–8	.....	.....	.46	.01	2.70	3.59	1.50	.77	(a)	(a)	(a)	9.03
Average	.01	.27	.81	2.03	2.55	2.67	2.20	2.88	1.30	.81	.13	15.62

[a] No record after April 15.

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From these records it will be noted that the average annual rainfall at Modesto for twenty years is 12.42 inches, although the records obtained by the Weather Bureau are something less, and at Oakdale for twenty-three years it is 15.62 inches; that the principal rainfall occurs during the months from November to March, inclusive; that a very much smaller amount occurs during April and May; and that during the months from June to September, inclusive, the precipitation is very slight.

In the parts of the area which have not yet been brought under irrigation the crops are dependent not only upon the amount of rainfall but very largely upon its distribution. A rainfall of from 7 to 10 inches, if well distributed, is sufficient to insure a crop of grain, but if coming at unfavorable seasons or not well distributed even a larger rainfall does not insure a crop. It is usually desirable to have sufficient precipitation in the fall to moisten the soil deep enough for plowing and to start the grain well; then with occasional rains during the winter and spring until the ground is well shaded fair grain crops are assured. Even in the irrigated sections these winter and spring rains are of great value in keeping the soil in proper condition.

AGRICULTURE.

The early settlers in this section were engaged principally in stock raising, as had been the Mexicans who preceded them, but as far back as the early fifties some of them had begun farming in a small way. Stock raising, however, continued to be the principal business until several years later. About 1867 grain farming on a large scale began and rapidly increased until 1872, when Stanislaus County became the banner grain-producing county of the State, the yield for that year being approximately 5,000,000 bushels, and the county has ranked high in the production of grain ever since. This change from a stock-raising to a grain-producing country was due to the productive nature of the soil, combined with the methods adopted, which made the sowing of a large acreage comparatively easy and gave large returns on the money invested.

Although the irrigated sections of the Modesto-Turlock area are attracting much attention and the consideration of their problems occupies a correspondingly large part of this report, the fact must not be overlooked that at present much more than half of the area is devoted to grain growing and that a very large part of it will probably be so used for many years to come.

In this grain-growing section the methods employed are those that have been in use for many years. The ground is plowed to a depth of from 3 to 6 inches with a gang plow drawn by 8 to 12 mules, plowing from 6 to 8 acres a day.

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Two methods of sowing are used. One plan is to summer fallow; that is, the ground is plowed during the winter and spring and allowed to lie exposed to sun and wind until the next fall, when it is again cultivated either by replowing or by harrowing and then sown. When impracticable to summer fallow, the ground is plowed after the fall rains have begun, and immediately sown, an attachment for seeding being used on the plows, so that the ground is plowed, seeded, and cultivated at the same time. Grain sown in this way is said to be winter sown. Although a crop is harvested only every alternate year when the land is summer fallowed, the yields are ordinarily almost twice as large as on the land which has been winter sown, except in the case of the bottom lands, where under favorable conditions good crops are sometimes secured every year.

For many years headers and thrashing machines were used, but at present the harvesting is done almost exclusively by combined harvesters, which cut, thrash, and sack the grain at the same time, thus harvesting from 30 to 40 acres a day. These harvesters are usually drawn by teams of from 24 to 32 mules, although traction engines both for harvesting and for plowing are used to some extent. Self-binders also have been used to a small extent during the last few years.

In the earlier days of grain farming wheat was grown almost exclusively, but for several years past the acreage of barley has greatly increased, and at present oats are being sown to a greater extent than ever before. While no records are obtainable covering the exact area included in this report, the relative importance of these crops is well shown in the statistics for Stanislaus County for the year 1906–7, compiled by order of the board of supervisors. This gives the area of these grains as follows: Wheat, 179,956 acres; barley, 87,663 acres; and oats, 24,115 acres. The variations of soil, of seasons, and of methods of farming are so great that it is impossible to give the yields of grain except within very wide limits, but on the better soil a yield of from 8 to 14 sacks of wheat or 10 to 16 sacks of barley or oats to the acre is considered a good yield on summer fallow, while winter-sown grain yields a little more than half these quantities. On poorer soil or under unfavorable climatic conditions the yields vary from this minimum to a crop which will not pay for harvesting.

For many years no more prosperous people could be found than the men who were engaged in raising grain in this part of the San Joaquin Valley, but for several years past the grain men of this section, like those of almost the entire State, have made much smaller profits than they once did, and, in fact, the case of men who have lost heavily on grain crops is not uncommon. This decline in a business once so profitable is due to a number of causes, among which the most important are decreased yields, lower prices, and increased cost of labor and work animals.

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The decreased yields are due to the improper conditions of the surface soil from continued cropping, to the formation of a plowsole at the average depth of cultivation, and to lack of thorough cultivation of the summer fallow. It has also been shown that the wheat crops in California could be considerably increased by using more care in the selection of seed.[a]

Hundreds of examinations in the grain fields during the dry season the past year showed almost invariably at a depth of from 4 to 6 inches a hard, compact layer, varying in thickness from 2 to 4 or 5 inches, entirely different from hardpan and almost impenetrable to the soil auger. This has been caused by successive plowings for years to about the same depth, thus allowing the rain water to penetrate to this depth readily, but checking its progress farther, and at the same time cutting off the soil from capillary supplies from below. In the warm, dry weather the moisture in this surface soil above the plowsole is soon exhausted, and the plants suffer. The most important thing, then, for the farmer who would improve his yield is an occasional deep plowing and under some conditions a thorough subsoiling.

Some farmers have obtained excellent results from subsoiling, the beneficial effects being noticeable in increased crop yields for the following two or three years. Other grain farmers have found subsoiling on shallow soils harmful, the yield being reduced not only for that season, but for the following seasons, so that this, like so many other problems on the farm, must be worked out by each farmer for himself. One of the most successful grain farmers in this area avoids the formation of a plowsole by varying the depth to which he plows, making each plowing an inch shallower or deeper than the preceding plowing.

One of the principal purposes of summer fallowing is to conserve the moisture and to enrich the soil through nitrification, which takes place best in a loose, porous soil under such heat and moisture conditions as are obtained in well-cultivated fallowed land.

Another purpose is to prepare a seed bed in which the soil shall be in the best possible physical condition. It should be loose and granular and contain sufficient moisture to sustain growing plants. This can best be obtained by plowing the ground when in good moisture condition and following the plows closely by some leveling and pulverizing implement, such as a harrow, until the surface is smooth and loose. This surface mulch retains the moisture in the ground for future use. It is not uncommon to see grain land plowed when not in good condition and left quite rough. When in this condition

[a] Shaw, California Experiment Station Bulletin No. 181.

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the soil bakes very hard, the moisture is soon almost entirely removed, nitrification can not take place, and little is gained under such conditions by the summer fallow. Should the surface become compacted by rains after it has been leveled, it should again be cultivated to restore the mulch. At intervals during the summer surface cultivation to break up the crust which forms and to prevent the escape of moisture from below should be given, but unless necessary to prevent the growth of weeds and grass a second plowing until seeding time in the fall will not be necessary. If, however, a second or even a third plowing in the spring is necessary, it should be very shallow and should be followed, as should also the fall plowing, by thorough surface cultivation. By these means moisture enough to start the grain well will be retained from the previous season's rainfall.

In the early spring much damage is done to grain crops by the formation of a surface crust, which pinches the tender plants and retards their growth until a rain comes to soften the crust. This crust also permits of the escape of moisture from below. Cultivation of grain crops early in the spring with a light sharp-toothed harrow is often found very beneficial, especially when dry weather follows. This injures the grain to some extent, it is true, but the benefits derived from a breaking of the crust and the formation of a loose surface mulch overbalance the injury done to the grain.

In the dry-farming sections of Utah much better results are obtained by thin than by thick seeding,[a] good crops often being secured when only 35 to 45 pounds of wheat per acre are sown, but under the same field conditions only half a crop when 75 pounds are sown. Experiments to determine the effect of thin seeding in the San Joaquin Valley would be of interest and might easily be carried on by any grain rancher.

Although only a very limited rotation with the crops at present grown can be arranged, better results may be obtained by following each crop with one of a different kind than by the continued use of one crop.

It is believed, then, that by a breaking up of the plowsole, by conserving the moisture with a surface soil mulch, by rotation of crops, by using the most favorable amount of seed, and by sowing seed of good quality, the yield of dry-farmed grain can be considerably increased. The difficulty of practicing such thorough methods where grain ranches are as large as they are in this section is not underestimated, but if the grain farmers are to become as prosperous as their neighbors of the irrigated sections they must improve upon the prevailing methods of farming.

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[a] Scofield, Bulletin No. 130, Bureau of Plant Industry.

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Since the beginning of irrigation in this area the price of land has increased very materially. At its beginning in 1901 the better grain land, if for sale at all, could be bought at prices ranging from $30 to $45 an acre, while the poorer grain land, including the large body of sandy soils in the southwest part of the area, could be bought for $10 or less an acre. At the present time the prevailing price for first-class land in small tracts is $100 an acre, although some excellent tracts are on the market at prices ranging from $60 to $90 an acre. For poorer land the price varies from $40 an acre up. In tracts of several hundred acres the price is usually considerably less than is asked for the small subdivisions.

The bottom lands along the Tuolumne and Stanislaus rivers and also along Little John Creek, although not irrigated, are held at prices ranging from $75 to $100 or more an acre, while the nonirrigated grain lands are held at $15 to $25 or more. Improved irrigated lands are selling at prices ranging from $75 to $200 an acre, the price depending upon the kind of soil and character of the improvements.

If a man wishes to engage in alfalfa growing and the dairy business in a small way, 30 or 40 acres of good land is sufficient, and even then the employment of help will be necessary. If he wishes to grow fruit, berries, or vegetables a good living for a family of moderate size can be made on a farm of 20 acres or less.

Labor is often inefficient and hard to secure. The price paid for men on the grain ranches is $30 to $40 a month and board, and during grain harvest $2.50 to $4 a day, the price depending upon the kind of work done. The price paid for day labor is $1.50 to $2.50 a day without board. Much of the work in vineyards, as picking fruit and other like work, is done by contract, largely by Japanese.

SOILS.

The soils of the Modesto-Turlock area are very complex in character and distribution. Not only is there a great range in kinds extending from sand to the heaviest adobe, but the occurrence of small bodies of one soil within or partly surrounded by those of entirely different character is quite usual. In fact the occurrence of several distinct and widely differing soils within a 10-acre tract or even within a single acre is not uncommon.

On a scale of 1 inch to the mile, which is used in the soil survey, it is impracticable to show a soil body of much less than 10 acres, so that it has often been necessary to include a small soil body of one type within that of an entirely different one which surrounds it. In other places, where there is a multiplicity of small soil bodies of different character, it has been necessary to map the whole with the soil which it most nearly resembles.

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At some former time the only part of the area covered by this survey which existed as land, was the hills in the northeastern part. West and south of these a great body of water extended entirely across the valley to the Coast Range. These hills themselves were also formed under water, but at an earlier date, and were part of a gently sloping, smooth ocean or lake bed like that which now exists in the valley west of them. This is shown by the horizontal position of the beds of rock which compose them, the same beds being found at about the same elevation in different hills. While the remainder of the valley was protected from erosion by the water which covered it, this portion was raised and exposed, and by erosion carved into its present form. These hills are made up of various kinds of rock, which in the northern part of the area consist largely of a coarse, horizontally bedded sandstone, which often outcrops near the tops of the hills, as may be seen east and north of Oakdale. These are really an andesitic tufa which weathers into a heavy purplish-brown adobe. Farther south the prevailing beds are older and are those of a buff-colored stratified silt or clay which weathers into a bluish-black adobe. These two types of adobe, however, are so closely related and so blended that in the soil map they have not been separated. Still farther south the predominating outcropping beds are those of sharp sand very largely granitic in origin which weather into a rough, sharp sandy loam. In some places beds of a fine chocolate-brown sand occur and weather into a fine sandy loam of like nature. Through many parts of the area a mixture of these various soils has resulted in a loam which has some of the characteristics of each. These soils have no hardpan in the true sense of the word, but are underlain at various depths by the formations from which they are derived. They have been called the Arnold soils. The Oakdale line of the Southern Pacific Railroad approximately separates these types from the soils of the lower part of the valley.

The topography of this section is markedly different from that of the remainder of the area and consists of well-rounded hills, the highest of which reach an elevation of 200 feet or more above sea level. These stretch away in all directions like immense billows of almost uniform slope, only a narrow valley here and there serving to break the monotony. Although the slopes of these hills are steep they are usually smooth and the entire surface is cultivated, except where an outcrop of the underlying formation occurs. The Arnold soils are characterized by brown color, and the frequent occurrence of the subsoil near the surface.

West and southwest of the Arnold soils there was formed along the margin of the old lake which covered the valley floor, from the action of its waters upon the material washed into it from the adjacent hills,

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a series of peculiar red soils, usually light and sandy at the surface but underlain by a heavier subsoil, which is in turn underlain by an indurated ferruginous hardpan. These are easily recognized by their brick-red or yellowish-red color and by the dense, red hardpan. These are called the San Joaquin soils.

During the existence of the Pleistocene lake, though probably while it was receding, the Stanislaus, Tuolumne, and Merced rivers brought down from the mountains sands worn from granite, quartz, porphyry, and the numerous other rocks of which the mountains are composed, and emptied them into its waters. These sands were carried by the currents until they were distributed along its shores and over its bed, and now form the basis of the great body of gray sandy soils, underlain by white hardpan, which stretch from the red soils on the east almost to the San Joaquin River. Soils of this description belong to the widespread Fresno series.

After the old Pleistocene lake had been emptied into Suisun Bay, probably by means of a fissure caused by an earthquake, the Stanislaus River would at times overflow the bluffs, which were then its banks, and flow across country, leaving strips of sand and gravel to mark its course. Even the Tuolumne and Merced rivers and Dry Creek laid down similar deposits, but not to so great an extent. As these streams continued to cut deeper channels they sometimes wandered to one side or the other, leaving the benches or terraces now to be seen along their courses. As the channels grew deeper their overflow was confined to the bottom lands which lie but a few feet above their beds. These more recent soils, consisting of the old overflow channels and of the soils which are now year by year being formed along these streams and along the San Joaquin River, make up the fourth group and have been designated by different local names.

There are in the area four broad classes of soils—the sandy and adobe soils of the higher foothills, the red soils underlain by indurated red hardpan, the ashy-gray sandy soils underlain by white hardpan, and the more recent coarse sandy soils of the old stream courses and bench lands, with the silty soils of the stream bottoms. Each has been greatly modified by numerous agencies since it was first laid down. Rains have worn down the hills, carrying the coarser material but a short distance, while the finer clay and silt have been carried well out into the valley to mix with its sands. Poorly drained areas have been filled with water, and by its action their soils have been greatly modified, that which was once loose and coarse becoming sticky and heavy. Winds have scooped out the looser sands in places and piled them up in others. Plant life has added organic matter where it could flourish, but left the soil destitute where it could not. So through differences which originally existed and through the action of modifying agencies each of these broad divi-

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sions may be separated into other groups, or series, and these series into soil types.

The following table shows the number of acres of each soil type in the Modesto-Turlock area:

Areas of different soils.

Soils.	Acres.	Per cent.	Soils.	Acres.	Per cent.
Fresno sand	117,504	22.7	Modesto loam	8,896	1.7
Fresno sandy loam	111,616	21.6	Stockton clay loam	8,512	1.6
San Joaquin sandy loam	75,328	14.6	Fresno fine sand	5,440	1.1
Fresno fine sandy loam	26,496	5.1	Stockton clay adobe	3,456	.7
Oakdale coarse sandy loam	26,304	5.1	Sacramento sandy loam	2,432	.5
Arnold clay adobe	23,296	4.5	Oakdale sandy loam	2,432	.5
Hanford silt loam	21,696	4.2	Arnold fine sandy loam	2,240	.4
Arnold loam	21,504	4.2	Oakdale sand	2,048	.4
Sacramento silt loam	16,960	3.3	Riverwash	576	.1
Fresno loam	15,552	3.0	Stockton loam	512	.1
San Joaquin loam	14,976	2.8			
Arnold sandy loam	9,344	1.8	Total	517,120	.....

From this table it will be noted that more than half of the area surveyed is occupied by soils belonging to the Fresno series, of which the Fresno sand covers the largest area, though the area covered is only slightly in excess of that covered by the Fresno sandy loam. The San Joaquin soils occupy approximately one-sixth of the area, the Arnold one-ninth, the Oakdale one-sixteenth, and the Sacramento and Hanford somewhat less than this last amount.

FRESNO SANDY LOAM.

The Fresno sandy loam and fine sandy loam, owing to a peculiar ashy-gray color at the immediate surface, when dry are known in many parts of the San Joaquin Valley as "white-ash land." The former is made up of rather sharp, medium to fine sand, largely granitic in origin, but also contains enough silt and clay to make it quite sticky when wet, puddling easily and forming a crust at the surface when it becomes dry. The soil proper is light brown or grayish brown to occasionally chocolate brown in color. Below the surface foot it usually becomes a lighter color and somewhat heavier in texture, and at a depth of from 30 inches to 5 feet or more is underlain by a silty layer quite similar to the white silty material found in the hills of the eastern part of the area. This silty layer may in turn be underlain by a sticky sandy loam, or it may continue to the depth of 6 feet or more. At the surface of this material, or occasionally below the surface, it is cemented by carbonate of lime into a white hardpan varying in hardness from a slightly cemented mass, which easily disintegrates, to material so firmly indurated that it is practically impenetrable to plant roots and impervious to water.

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The Fresno sandy loam is subject to considerable variation in color, texture, and crop value. In the vicinity of Modesto it has been modified by the same agencies which helped to form the Modesto loam, in places being a decided brown and heavy, while in others it contains a very large quantity of coarse, sharp sand and fine gravel. These local areas of coarse material, together with others in which the soil is almost a fine sandy loam, occur throughout this section. The surface of the best of this soil is usually smooth and level, or at most only gently sloping, so that it requires little work to prepare it for irrigation. The level portions are also usually of better depth than where the surface is hummocky or marked by numerous depressions or "hog wallows," the latter being almost certain indications of shallow soil and indurated hardpan.

Extensive areas of the best phase of Fresno sandy loam are found west and southwest of Ripon, surrounding Salida, north of Modesto, on the McHenry road, extending from Ceres to Hickman, south of Keyes, west of Waterford, and in smaller bodies throughout a large part of the survey. South of the Tuolumne River a considerable area has been mapped as a sandy loam which contains a very large percentage of sand, but also enough finer material to come just within the limits of a sandy loam. In the entire western part of the area this soil has a more uneven surface, is shallower, and also contains alkali. This is especially noticeable in certain areas between the Tuolumne and Merced rivers, where on account of its uneven surface, shallow soil, indurated hardpan, and alkali content it is of little value except for grazing purposes.

Under the old system of dry farming the Fresno sandy loam was one of the most productive grain soils, and when so farmed still produces good crops. Where it is of good depth and well drained it is a productive, easily cultivated soil, well suited to irrigation. It is one of the best alfalfa soils in the area, and taken as a whole is the most valuable soil for general agricultural and horticultural purposes. Figs, peaches, olives, berries, vines, melons, vegetables, and in fact any plant suited to this climate and requiring a warm, light soil can be grown on it successfully.

The following table gives the average results of mechanical analyses of samples of this soil.

Mechanical analyses of Fresno sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
17023, 18034	Soil	1.7	11.9	11.0	26.8	10.7	32.7	5.3
17024	Subsoil	1.0	7.6	6.8	23.4	6.7	46.3	7.3

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FRESNO FINE SANDY LOAM.

The Fresno fine sandy loam somewhat resembles the Fresno sandy loam in color at the surface, having the same ashy-gray color though usually having a lighter gray appearance when dry. When moist, the soil becomes light brown in color and sometimes has a slightly greenish tinge. It is composed of fine sand and very fine sand mixed with a considerable quantity of silt and clay. When rubbed between the fingers it has a smooth, velvety feel. At a depth of 15 inches to 5 feet or more it is underlain by the same silty subsoil found under the sandy loam, but the hardpan seems to be more firmly cemented and the surface more generally uneven than that of the sandy loam, often being marked by the "hog-wallow" depressions. It also more frequently carries alkali than does the sandy loam. The same condition of shallow soil and alkali noted in the sandy loam in the vicinity of the San Joaquin River is also found on this soil.

Usually the Fresno fine sandy loam occurs in comparatively small bodies. Many of these, too small to be shown in the map, are included in the areas of sandy loam. Between Waterford and Modesto a rather large area of this soil is found, the eastern portion of which has a smoother surface and greater depth than is found elsewhere in the survey.

The Fresno fine sandy loam when dry-farmed has probably been the most productive upland grain soil and is still quite productive. Where of good depth, free from alkali, and well drained, it is well suited to alfalfa, vines, figs, peaches, and other orchard crops, and is especially suited to berries, sweet potatoes, melons, and crops requiring constant and thorough cultivation.

The following table gives the results of mechanical analyses of this soil:

Mechanical analyses of Fresno fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18894	Soil	0.2	5.1	3.5	25.4	18.5	39.6	7.1
18895	Subsoil	.5	5.0	4.3	27.9	20.1	33.8	8.1

FRESNO SAND.

The Fresno sand, as found in this area, is a medium to fine, loose, incoherent, micaceous sand, often containing considerable coarse, sharp, granitic material. In other places the soil is almost a fine sand in texture, these areas of fine material usually being due to a sorting of the fine material by the wind. In color it is light brown or yellowish brown, usually somewhat lighter below the surface foot, though typically it differs but slightly in color or texture to a depth

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of 6 feet or more. It is very loose at the surface and does not compact in the roads after rains, but even in this soil a plow sole is sometimes formed. When cultivated, the surface is readily drifted by the winds, causing considerable damage to young crops and recently planted vines.

In many parts of the area the sand has collected in dunelike ridges or in billowy areas and is so deep and loose that the rooting of trees and vines is very difficult, but if a foothold can once be secured it proves quite productive. This sand contains a higher percentage of fine sand than does the undrifted soil, but otherwise does not differ from it. The largest of these drifted areas occur southeast of Manteca and in the vicinity of Delhi and have been indicated on the soil map by the proper symbol, but many smaller areas of drifted sand occur throughout the survey and others may be formed wherever sand areas are cultivated and left exposed to the action of the wind.

Although typically 6 feet deep, there are certain sections, especially in the vicinity of the San Joaquin River and in the southwestern part of the area, where the Fresno sand is underlain by hardpan at depths varying from 1 to 4 feet. These shallower areas usually contain some alkali.

When farmed to grain, the Fresno sand in favorable seasons at first produces fair yields, but it rapidly declines in production, and for several years a large part of it has been practically abandoned for grain farming. Since the beginning of irrigation extensive areas have been used, especially in the vicinity of Turlock, for the growing of sweet potatoes, cantaloupes, berries, and garden truck, and very large and satisfactory yields have been obtained. It is also being used extensively for peaches and vines, a large acreage of the latter being planted on it in the vicinity of Manteca.

When used for alfalfa the results obtained have not been very satisfactory, probably owing to a considerable extent to overirrigation and too heavy pasturing. For this crop the soil could be improved by the use of manure. Where well drained and of good depth, the Fresno sand shows special adaptation to certain varieties of peaches, grapes, almonds, olives, and to sweet potatoes and melons, but when the two last-named crops are grown, their rotation with other crops will be necessary. Several concrete examples of crops grown on this soil are given under the head of crop adaptation.

The following table gives the average results of mechanical analyses of this soil:

Mechanical analyses of Fresno sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18883, 18887	Soil	1.0	12.7	19.9	41.1	15.9	7.4	1.7
18884	Subsoil	2.1	21.6	15.4	36.0	16.2	6.6	1.9

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FRESNO FINE SAND.

The soil of the Fresno fine sand is grayish brown or greenish brown, and in the western part of the area very dark brown in color, is smooth and micaceous, and made up almost entirely of fine sand and very fine sand. At a depth of from 3 to 5 feet the silty subsoil of the Fresno series is usually encountered, but in numerous places the surface foot of soil grades into material similar to that composing the Fresno sand or Fresno sandy loam, which in turn is underlain by the Fresno hardpan. The surface is smooth and level and the soil is easily cultivated. Owing to its high capillary power, alkali, if present in the subsoil even in very small quantities, comes to the surface readily under favorable conditions, its presence being indicated by moist spots.

This soil is usually of good depth and well suited to irrigated crops. Alfalfa, trees, and vines do well. Like the better parts of the fine sandy loam it is especially well adapted to those crops which require constant cultivation.

It occurs in numerous rather small bodies scattered throughout a large part of the area, the largest of these being west of Ripon and in the vicinity of Escalon.

The following table gives the results of mechanical analyses of this soil:

Mechanical analyses of Fresno fine sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18888	Soil	2.2	10.9	8.0	40.0	15.7	17.5	5.5
18889	Subsoil	1.3	9.3	9.0	41.6	16.1	16.9	6.2

FRESNO LOAM.

The Fresno loam, as mapped in this area, is an ashy-gray or brown silty loam soil, containing sufficient sharp medium sand to give it a rough, gritty feel. When in good moisture conditions it is quite friable, especially near the surface, but when wet is very sticky, having a plastic, puttylike appearance and puddling readily. The subsoil is usually slightly heavier than the surface soil, and where exposed to the weather shows an adobe structure. It is underlain by calcareous hardpan at a depth of 1½ to 5 feet.

This soil occurs principally in the vicinity of the San Joaquin River, although a few small areas occur north of Modesto, and has been formed by the wash from adjacent areas and the action of the water on the soils where poorly drained. It is characterized by a hummocky, uneven surface, although some of the areas are comparatively level, and by the frequent occurrence of barren white spots on the

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surface. These usually contain a rather high percentage of alkali, a part of which is the injurious carbonate or black alkali, but the soil quite close to these spots may be comparatively free from alkali.

This soil has been dry-farmed to grain to some extent, but on account of its uneven surface, puddling tendencies, and the comparatively high percentage of alkali which it contains, it is not of much value except for grazing purposes. It is unsuited for irrigation and irrigated crops.

The following table gives the average results of mechanical analyses of this soil:

Mechanical analyses of Fresno loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
17025, 18311, 18313.	Soil.....	0.5	4.2	3.0	12.3	15.0	46.3	18.8
17026, 18312, 18314.	Subsoil.....	.7	4.7	3.5	12.5	17.0	39.8	21.3

The following sample contained more than one-half of 1 per cent of calcium carbonate ($CaCO_3$): No. 18312, 0.95 per cent.

SAN JOAQUIN SANDY LOAM.

The San Joaquin sandy loam consists of a fine-textured bright brick-red sandy loam. The sand grains are sharp, making the soil rough and harsh. At a depth of from 15 to 60 inches the surface material is underlain by a ferruginous hardpan, the upper part of which is impenetrable to plant roots, and below this is a soft yellow incoherent sandstone. Between the surface soil and the hardpan a layer of heavy red loam or clay loam often occurs. This varies from 1 or 2 to several inches in thickness, and in some parts of the area is entirely wanting, the sandy soil resting directly upon the hardpan.

Under proper moisture conditions this soil is loose and friable, but when wet it becomes very sticky and upon drying excessively hard. During the rainy season or when irrigated, on account of the hardpan, the water is held near the surface, which then becomes quite soft and miry.

This soil is subject to considerable variation in color, often having a gray or brown appearance at the surface, although the subsoil retains the red color. In depth it sometimes extends 5 feet or even more, although over the larger part of the area the hardpan occurs at a depth of not more than 30 inches and in many places may be found at a depth of less than 15 inches. In texture the soil varies from a sandy loam, or in some cases from a fine sandy loam, to a loam, the gray color, slightly finer texture, and greater depth often occurring together.

Small bodies of the San Joaquin sandy loam of more than usual depth occur between Oakdale and Thalheim west of the railroad, east

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of Escalon, south of Hickman, east of Oakdale, and in a few other places, while shallow areas occur in the vicinity of Claus, northwest of Thalheim, and in numerous other places.

Over a large part of the area the surface is that of a comparatively level valley floor, except where pitted by small hog wallows or slightly larger shallow depressions. Where it extends into the foothills, however, it frequently occurs as well rounded hills of low elevation or partly dissected bench lands.

Along its western margin a few low hills of this soil also protrude through the surrounding Fresno soils. It extends in a broad, though not continuous, belt parallel with the general trend of the valley, the larger part of which is included between the Atchison, Topeka and Sante Fe Railway and the Oakdale line of the Southern Pacific.

The soil is usually free from gravel, although in the northern part of the area a few small bodies have a considerable quantity of small, well rounded pebbles and gravel scattered over the surface and through the soil.

The San Joaquin sandy loam has been used extensively for dry-farming, and in the early days under favorable conditions gave good yields of grain, but by constant cropping and through poor methods of handling the yields have greatly decreased. Although not well adapted to irrigation, except where of more than average depth, preparations are being made to irrigate considerable bodies of this soil. Where it is of sufficient depth and proper care is used this may be done successfully, but where the soil is shallow and drainage poor it will be a very difficult problem. A large part of this soil is suited only to grain, beans, and other shallow-rooting crops which can be grown by dry-farming methods. Where the drainage is good and the soil has a depth of 30 inches or more it can be used for vines, figs, olives, citrus fruits, and other crops suited to this climate.

The following table gives the average results of mechanical analyses of the San Joaquin sandy loam:

Mechanical analyses of San Joaquin sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
17790, 17792, 18919.	Soil.....	3.7	17.2	8.0	22.9	12.4	27.8	8.2
17791, 17793, 18920.	Subsoil.....	3.2	14.3	7.7	30.5	13.0	28.4	12.4

SAN JOAQUIN LOAM.

The San Joaquin loam, like the sandy loam, is red in color and underlain by the ferruginous hardpan, but is subject to greater color and textural variation than the lighter soil. Typically it is a heavy

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sticky loam containing considerable sharp sand. Under proper moisture conditions it is loose and friable, but when wet it puddles easily and upon drying bakes very hard, the heavier portions cracking and showing an adobe structure. At a depth of 3 or 4 to 12 inches it grades into a clay loam, heavy and adobelike, and is underlain by hardpan at a depth of from 15 to 30 inches. In some of the poorly drained areas this soil has a mottled gray and brown appearance. Many small spots, which on account of their size can not be shown on the map, although of an adobe structure, are included with the loam. This soil, especially the heavier portions, is difficult to cultivate, and especially so when irrigated. In places there are surface indications of alkali, but several examinations of the most pronounced spots failed to show the presence of enough alkali to be injurious to plant growth.

In the lower portions of the foothills in the northeastern part of the survey a few small areas of a red gravelly loam have been correlated with this soil, although closely related to the older soils of the hills and also closely resembling the soils of the Redding series which occur in the northern part of the Sacramento Valley. The soil varies in color from a brick red to brown, usually contains waterworn gravel, and in places is underlain by a red conglomerate instead of by the red hardpan of the lower soils. The top soil is frequently a very light loam, but at a depth of from 6 to 20 inches grades into a very heavy red loam or clay loam, which is in turn underlain by the red conglomerate at a depth of from 15 to 30 inches. This phase of the San Joaquin loam is used principally for grain and pasture. Under a thorough system of cultivation the deeper portions might be used for vines and trees.

The following table gives the average results of mechanical analyses of the soil and subsoil of the San Joaquin loam:

Mechanical analyses of San Joaquin loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
17797, 18917, 18921.	Soil.....	2.2	9.5	6.1	15.0	12.1	40.1	14.7
17798, 18918, 18922.	Subsoil.....	1.6	8.1	5.1	12.5	9.9	30.5	32.8

ARNOLD SANDY LOAM.

The Arnold sandy loam is a gray or brown sandy loam containing a large percentage of coarse, sharp sand, largely of granite and quartz particles, and considerable fine material. Small waterworn gravel and pebbles often occur on the surface and scattered through the soil mass. A few inches of the surface soil may be in some cases

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very light, but at the depth of a few inches it grades into a heavier soil composed very largely of coarser sand, silt, and clay, the clay giving it a very sticky, plastic texture. This sticky subsoil, which is yellowish red in color, usually persists to a depth of 6 feet or more. This subsoil holds moisture to a remarkable degree, numerous examinations during the dry season showing the soil at a depth of only a few inches, in summer fallow, to be in good moisture condition, and that at the depth of 2 feet or more almost saturated.

The Arnold sandy loam comes from the weathering of the sandy beds found in the foothills and may occur in any position in these hills, covering the entire surface, or only the crest, side, or base. The largest areas of it lie northeast of Waterford, but many small areas are found throughout the section covered by the Arnold soils. In the valley of Dry Creek, on the eastern margin of the area, a small body of level sandy loam, although not typical, has been correlated with this soil. The Arnold sandy loam has been used almost exclusively for dry farming to grain and under favorable conditions produces fairly good crops, though not so good as those produced on the heavier soils of the series.

If properly managed, it is believed that grapes, olives, almonds, and figs could be grown on many areas without irrigation. The discussion of this will receive further attention under the head of irrigation and dry farming.

The following table gives the results of mechanical analyses of the soil and subsoil of the Arnold sandy loam:

Mechanical analyses of Arnold sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
17811	Soil	10.2	29.4	10.3	12.4	3.5	24.6	9.6
17812	Subsoil	5.0	29.0	13.1	11.2	1.8	18.8	20.7

ARNOLD FINE SANDY LOAM.

The Arnold fine sandy loam is a chocolate-brown, smooth, micaceous fine sandy loam, occasionally containing waterworn gravel. It is friable and easily cultivated and holds moisture well. The subsoil differs but little in color or texture from the surface soil. At a depth of 3 to 5 feet it is underlain by more resistant beds of formation similar in texture.

This type of soil occupies the crests of a few of the hills 4 miles north of Waterford and a few small areas along the south side of the Stanislaus River above the terraces. This soil, like the sandy loam, has been used almost exclusively for grain. If irrigated, it

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would be well adapted to fruit, vegetables, and grapes, and on the deeper phases of it these might even be grown without irrigation.

The following table gives the average results of mechanical analyses of this soil:

Mechanical analyses of Arnold fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
17813, 17815	Soil	0.5	5.7	6.5	30.6	13.5	36.4	6.3
17814, 17816	Subsoil	.4	5.2	5.7	28.8	16.4	32.4	10.1

ARNOLD LOAM.

The Arnold loam is typically a grayish-brown soil slightly tinged with the purplish hue of the andesite rocks, but in many places it approaches the red of the San Joaquin soils, while in others it is a chocolate-brown color, sometimes almost black, the colors blending into each other and occurring without reference to position, so that the hills often have a mottled appearance. In texture it varies from a coarse sandy loam, in which the sand is sharp, to a heavy dark-colored loam. Usually the surface is light in texture, often resembling the Arnold sandy loam, but the soil immediately below the surface is so heavy that the type is classed as a loam. At a depth of 10 to 15 inches the soil grades into a heavy, sticky, light-brown loam or clay loam containing coarse sand, which in many places is underlain at 30 to 45 inches by a yellowish-brown silty sandstone.

The topography of the loam, like that of the sandy loam, is of the undulating hill type and the areas occur in any position on the hills or entirely covering them. Irregular bodies of this soil are found throughout the area covered by the Arnold soils, the larger part of the type lying, however, along the border between the Arnold and San Joaquin soils. It has been used almost exclusively for dry farming to grain, and under favorable conditions is the most productive soil of the series. While not usually so deep or so retentive of moisture as the sandy loam, it is believed that by thorough cultivation much could be done on the deeper portions of it to conserve the moisture and grow crops by dry-farming methods.

The following table gives the average results of mechanical analyses of this soil:

Mechanical analyses of Arnold loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
17799, 17803, 17806	Soil	2.9	12.1	6.7	16.9	7.3	44.2	10.4
17800, 17804, 17807	Subsoil	1.3	7.8	4.4	15.9	7.3	45.1	18.1

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ARNOLD CLAY ADOBE.

There are two phases of the Arnold clay adobe—a heavy purplish-brown adobe and a black, dark-gray or brown adobe, somewhat lighter in texture than the former. The two, however, are so closely related and grade so readily into each other that no attempt has been made to separate them. The heavier soil comes from the weathering in place of tufaceous andesitic beds, is very heavy, and cracks readily, but it also contains considerable coarse, sharp sand. It is in places very shallow, the underlying rock frequently showing at the surface, but it may have a depth of 2 or 3 feet or more. It is very difficult to cultivate and only fairly productive, and is used for dry farming or for pasture. The other phase is more easily cultivated and more productive. It consists of a smooth clay adobe containing little sand, and at a depth of 15 to 24 inches or more rests upon the light-colored beds of stratified silt. When wet it is very sticky and upon drying cracks badly, the cracks in many cases extending almost to the underlying rock formation.

In many places scattered through the soil and over the surface of the Arnold clay adobe are numerous well-rounded gravels and cobbles. The smaller gravel is smooth and well rounded, probably coming from the breaking down of the conglomerate beds already referred to, but much of the larger material is angular and only slightly rounded, having probably been carried to its present position by an old lava flow.

The surface of much of the Arnold clay adobe is comparatively level, but other portions extend along the hillsides or over their crests. Among the San Joaquin soils a few small and unimportant areas of adobe have been mapped and classed with the Arnold clay adobe, although probably more closely related to the former.

The following table gives the average results of mechanical analyses of fine-earth samples of the soil and subsoil of the Arnold clay adobe:

Mechanical analyses of Arnold clay adobe.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
17801, 17944	Soil	0.1	2.1	2.3	10.5	4.9	37.4	42.5
17802, 17945	Subsoil	1.8	12.5	5.3	12.1	9.5	46.3	11.9

SACRAMENTO SILT LOAM.

The Sacramento silt loam as found in this area is a chocolate-brown, reddish-brown, or yellowish-brown, very smooth micaceous silt loam. Typically it is uniform in texture to a depth of 6 to 20 feet or more, there being little difference between the surface soil and the subsoil.

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It is friable and easily cultivated, holds moisture well, does not puddle nor bake badly upon drying, and is especially adapted to irrigation. It has been formed by annual or occasional overflows of the streams along which it occurs, and is composed of the material worn from rocks of various kinds and from the washings of old mines. It also contains considerable organic matter from the soils which have been worked over and from the decay of plant growth. The higher, better drained, and more productive portions of this soil are now overflowed only at intervals of several years and are quite uniform, but the lower lying portions, which are overflowed almost every year, are much less uniform, the surface being uneven and the soil varying from almost a clay loam to a light, fine micaceous sandy loam, and in places being underlain at a depth of one to several feet by a sandy or gravelly loam. These more recent deposits are usually lighter in color, sometimes having a gray appearance. The sandier portions occur as elongated strips, while the heavier areas are lower and poorly drained, often having a heavy sticky subsoil.

This soil has been correlated with the Sacramento silt loam, although differing slightly from that soil as mapped in the Sacramento Valley. It has a somewhat higher silt content, the surface is more nearly level, and smoother, and the soil usually occupies the entire flood plain instead of only a portion of it near the river channel, as in the Sacramento Valley. As a whole, it also has a somewhat higher agricultural value.

The largest bodies of this soil in the area occur in the valley of the Stanislaus west of Oakdale and in the valley of the Tuolumne southwest of Modesto. Almost continuous, though in most places narrow, strips of it extend entirely across the area and for several miles east of it along the Stanislaus, Tuolumne, and Merced rivers, the soil in these three valleys being remarkably similar. In many places the area occupied by the Sacramento silt loam is bordered on one side by a semicircular bluff or terrace. That part adjacent to this terrace is often heavier in texture, poorly drained, and sometimes carries an appreciable quantity of alkali, this being of sufficient concentration in many small areas to be injurious to plant growth. In places this contains some sodium carbonate, or black alkali, but the principal part of it consists of sulphate, bicarbonate, and chlorides, or white alkali. These areas are too small to be shown on the alkali map.

The level, well-drained portions of the Sacramento silt loam are the most productive and easiest cultivated soils in the area. They have been farmed to grain extensively and have almost invariably given good yields. Even when cropped from year to year without summer fallowing fair yields are obtained. The yields on summer fallowed land in favorable seasons are not far from 20 sacks of wheat and 24 to 26 sacks of barley or oats to the acre.

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Considerable areas of this soil are used for alfalfa, this crop being grown without irrigation, and three or four cuttings of a ton or more each are obtained. The greatest difficulty encountered is the injury done by the gophers, which have an opportunity to work in the unirrigated soil. Sometimes the rank growth of weeds, especially upon the land that has been overflowed, is also a hindrance.

Practically all of the older orchards of the valley were planted on this soil. Although the greater number of them have died, this has been principally through neglect, and the soil is well adapted to fruit trees. The larger area devoted to orchards lies west of Oakdale, where a few hundred acres are planted in peaches, prunes, apricots, pears, grapes, and various other fruits. Most of these are grown without irrigation, sufficient moisture for the trees being retained in the soil by frequent cultivation. A few irrigating plants have been installed, but have usually been found unprofitable for orchard purposes.

Aside from the orchard interests, that of truck gardening is the most important. The gardeners are mainly Italians. Pumping plants are installed and crops of radishes, lettuce, turnips, onions, cabbage, cauliflower, carrots, beets, peas, peppers, corn, tomatoes, potatoes, melons, celery, and many other products follow each other in quick succession, one crop being removed and another immediately planted in its place throughout the year. The produce of these gardens is disposed of in the local markets through the grocery stores, distributed from wagons that have regular routes through the country, or is shipped to the cities and to the mines. Owing to the small areas devoted to each crop, the quick succession of crops on the same soil, and the difficulty of securing information from the men engaged in the business, it is impossible to give any figures as to the yields and profits made by these gardeners, but it is known that the profits are large. In addition to the crops now grown it is believed that hops, sugar beets, asparagus, and berries could be grown with good results and that within a few years the larger part of this soil will be used for such specialized crops.

The following table gives the average results of mechanical analyses of the Sacramento silt loam:

Mechanical analyses of Sacramento silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
17028, 17817.....	Soil.....	0.1	0.2	0.3	11.3	6.6	74.2	7.1
17029, 17818.....	Subsoil.....	.1	.5	.6	7.9	6.3	75.4	9.4

The following sample contained more than one-half of 1 per cent of calcium carbonate ($CaCO_3$): No. 17029, 1.14 per cent.

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SACRAMENTO SANDY LOAM.

Typically, the Sacramento sandy loam is a brown, micaceous, smooth, medium to fine sandy loam with a depth of 6 feet or more, but it is subject to considerable variation in color, texture, and depth. The coarser areas are gray in color, while the finer and heavier portions have the chocolate-brown color of the silt loam. In texture it varies from a very fine silty sandy loam to almost a medium fine sand, but it contains very little clay. While it usually has a depth of 6 feet or more, it may be underlain by coarse sand or gravel at any depth between 30 inches and 6 feet.

This soil has been deposited during recent overflows, and is made up of the sand and silt carried by the streams along which it occurs. The larger areas are comparatively level and usually higher than the small areas, which are frequently uneven and have ridges of sand extending across them. Numerous small areas of this type of soil occur in the lower and more recently overflowed portions of the Sacramento silt loam, and on account of their small size and the difficulty of accurately outlining them they have been mapped with the silt loam.

The principal bodies of this soil are found along the Tuolumne River west of Modesto, near the Paradise Gardens, but smaller areas occur in other places along the Tuolumne, Stanislaus, and Merced rivers. Owing to its limited extent, it is a comparatively unimportant type, used in part for orchards and for gardening. If well drained and protected from overflow, it would be well adapted to truck gardening, berries, and melons.

A mechanical analysis of a sample of this soil gives the following results:

Mechanical analysis of Sacramento sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18925	Soil	0.7	14.2	10.1	40.4	11.5	14.6	8.4

HANFORD SILT LOAM.

The Hanford silt loam is a brown, dark-brown, or nearly black, heavy, micaceous silt loam, containing considerable organic matter. When wet it is very sticky and puddles easily, and when dry the surface cracks and checks. There is considerable variation in the subsoil, the surface soil in places grading into a very heavy dark-colored silt or clay loam. At a depth of about 20 inches this grades into a whitish-brown silty loam, which often contains calcareous nodules and weathers into an adobe where exposed. At a depth of

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about 4 feet this is underlain by a very sticky, micaceous, gray or light-brown fine sandy loam, which becomes lighter in texture with increasing depth. In other places the surface soil grades into lighter colored, very micaceous silt loam at a depth of 6 or 8 inches, and this at a depth of about 12 inches into a smooth, micaceous fine sandy loam containing much silt. This may extend to a depth of 6 feet or more, or may be underlain at a depth of 4 or 5 feet by the heavy silt or clay loam above noted. While the surface soil has much the same appearance regardless of the subsoil, that which has the heavier subsoil usually occurs as the lower lying areas around lakes, lagoons, and old stream courses, while that having the lighter subsoil is higher and more nearly level.

This soil has been formed very largely from the deposition of material by the overflows from the San Joaquin River and its tributaries, a large part of it being flooded almost every year. It is made up of sand, silt, and clay, carried down and worked over by these streams, to which has been added considerable organic matter from a rank growth of native plants.

The heavier parts of this soil, especially those flat, low-lying areas somewhat away from the sloughs and lagoons, often contain a small quantity of alkali, both black and white alkali being present, but in a soil of this character a given quantity of alkali is less harmful and easier controlled than in a lighter soil.

The topography of this soil as a whole is that of a flat, smooth flood plain, though it has been much dissected by many deep sloughs and dry channels, left by swift flood waters. A few of these are located on the map, but many others, on account of their being almost inaccessible, are not shown. The lower lying areas have in many places ridges of sand and gravel on the surface, the result of recent deposition. The entire area is separated from the adjacent soils by a low bluff or terrace which in most places is quite distinct. Along the edge of the lowland just below this terrace a string of lakes connected by sloughs extend throughout the greater part of the area.

This soil occurs along the San Joaquin River in a long, narrow strip, varying in width from less than half a mile to 1½ miles. Much of it, especially that adjacent to the river, is covered by a growth of willows and underbrush, while on some of the higher parts is a growth of valley oak. Many of the broader, more level stretches have been cleared and used for grain. A few have been diked, pumping plants installed, and the soil sown to alfalfa, but owing to unusual high water during the past few years these dikes have been partly destroyed and the reclaimed portions abandoned. For the same reason little of this land is now used for grain, this entire body of rich alluvial bottom

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land being abandoned almost entirely to grazing. Although many parts of this soil, on account of uneven surface, areas of sand, and numerous sloughs and lakes, could not be prepared for cultivation without great expense, there are some comparatively level bodies of rich, productive soil, hundreds of acres in extent, that would well repay the cost of such reclamation as has been carried on in the vicinity of Stockton. If reclaimed by means of dikes and the installation of pumping plants for the removal of seepage water and for irrigation where needed, this soil would be found well adapted to alfalfa and garden truck of all kinds.

The average results of mechanical analyses of the soil and subsoil of Hanford silt loam are given in the following table:

Mechanical analyses of Hanford silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18911, 18914.....	Soil.....	0.1	0.7	0.3	2.2	4.4	62.1	30.8
18912, 18915.....	Subsoil.....	.0	.5	1.0	24.6	14.3	37.8	21.6

STOCKTON CLAY LOAM.

The Stockton clay loam is a smooth, silty, heavy loam or clay loam, of yellowish color. When wet it is slick and sticky and puddles readily, and when dry it cracks and becomes rather hard, but under favorable moisture conditions it is friable and easily cultivated. At a depth of 18 to 24 inches the surface soil grades into one of heavier texture, which shows an adobe structure upon weathering, but retains the light-yellow color of the surface soil. At a depth of 4 to 5 feet this is underlain by a light-yellow silty fine sandy loam. This soil is free from alkali and in that portion of the area near Farmington no hardpan is encountered within 6 feet of the surface. Farther east it is underlain in places by a rather heavy hardpan at a depth of 3 to 6 feet. As a whole, this is a comparatively uniform soil, though subject to some variation in color and texture, a few small areas being heavier and usually slightly darker in color, often brown or reddish brown.

The Stockton clay loam is sedimentary in origin, and has been carried down from the foothills by Little John Creek. Except for a few low-lying areas along the creek, it is not at present subject to overflow. It is a smooth, flat, or gently sloping flood plain, well adapted to cultivation. It occupies the small valley in which Farmington is located, in the extreme northern part of the area. It has been used principally for grain farming, giving yields of 8 to 10 sacks of wheat or 12 to 16 sacks of barley on summer fallow. A few

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small low-lying areas have been used for alfalfa, yielding two or three cuttings without irrigation. Some vineyards have been put out on this soil and give promise of making good growth and large yields, the Tokay grapes already grown being especially well colored. These vineyards have been grown without irrigation, sufficient moisture being conserved by cultivation. The soil is naturally adapted to the growing of grapes, peaches, prunes, figs, and, if irrigated, to alfalfa, berries, and garden truck.

The following table gives the average results of mechanical analyses of the soil and subsoil of the Stockton clay loam:

Mechanical analyses of Stockton clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18878, 18881	Soil	0.1	1.4	1.3	12.1	14.5	48.3	21.8
18879, 18882	Subsoil	.0	.6	1.3	13.8	11.9	46.0	26.2
18880	Lower subsoil	.0	.4	3.4	30.6	15.9	32.0	18.1

STOCKTON CLAY ADOBE.

The soil of the Stockton clay adobe is a yellowish-brown or dark-brown clay or clay loam of smooth uniform texture. It is sticky and puddles easily when wet and cracks when dry, the cracks extending to considerable depth. At a depth of about 20 inches it grades into a yellow clay or clay loam, which may extend to a depth of 2 feet or may in the lower part of the section grade into a yellow silty sandy loam.

In origin this soil does not differ essentially from the Stockton clay loam, but it differs in texture, being heavier, and in structure, being an adobe. It is also more difficult to cultivate. It occupies the valley of Rock Creek, northeast of Farmington, the poorer drained areas along the edge of the valley occupied by the Stockton clay loam, and also a small area on Dry Creek.

The results of mechanical analyses of the soil and subsoil are given in the following table:

Mechanical analyses of Stockton clay adobe.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18929	Soil	0.0	1.3	0.7	3.3	3.7	48.6	42.6
18930	Subsoil	.0	.8	.5	1.9	4.8	65.1	25.9

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OAKDALE COARSE SANDY LOAM.

The Oakdale coarse sandy loam is dark chocolate brown, reddish or yellowish brown, or occasionally almost black in color, and is made up of coarse, sharp sand and fine, sharp gravel, largely of granite and quartz rock. Adhering to this coarse material and in the spaces between the grains there is a considerable amount of smooth, fine, micaceous sand and silt. The soil varies considerably in texture, some of it being quite heavy and breaking up into large clods when cultivated. The larger part of it, however, is loose and incoherent when dry, and sticky when wet. Where used for roads or streets it compacts readily, making a firm, solid surface. In some areas a considerable quantity of waterworn gravel and pebbles occurs. Where these are sufficient to affect the crop value of the soil or its power to hold moisture, they have been indicated on the soil map by the proper symbol. At a depth of about 12 inches the soil is often lighter in color, showing a yellow or gray tinge, this probably being due to the absence of the small amount of organic matter found in the surface soil, but the texture often remains the same to a depth of 6 feet or more, although in many places, and especially where the soil has been irrigated for some time, the subsoil is much heavier.

This soil is free from hardpan and alkali and is well drained, except in the lower parts of some of the old channels, north and northwest of Modesto.

The Oakdale coarse sandy loam is sedimentary in origin and has come from the weathering and working over of the sand and gravel beds of the hills, which in places form the basis of the lighter members of the Arnold soils. An interesting outcrop of these beds may be seen at the north end of the wagon bridge across the Stanislaus River at Oakdale.

This soil is uniformly level, or almost so, and is well situated for irrigation and easy cultivation. The principal bodies are found along the Stanislaus River west from Oakdale, considerable bodies being located on both sides of the river. There are other small areas, some of the smaller ones on account of their size being mapped with the Fresno soils.

Southwest of Escalon, near Weston, and in other parts of the survey considerable bodies are so light that the soil is a coarse sand; but on account of the very slight difference in texture and crop value between this soil and the lighter portions of the Oakdale coarse sandy loam, these areas have been included with the latter soil.

Areas where the soil is loose and incoherent are of little value for grain, but some of the heavier portions produce fair crops. It is said that alfalfa gives poor yields and dies out badly, but this is

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probably due in part at least to careless methods of overirrigation, too heavy pasturing, and failure to supply needed humus. The soil seems especially adapted to the growing of strawberries, bramble berries, and almonds, for which it is used extensively in the vicinity of Oakdale. The berries are irrigated, but almonds are grown without irrigation. Olives, citrus fruits, vegetables, melons, and many other crops are produced with considerable success. Few vineyards in bearing are found on it, but where strips of it extend into recently planted vineyards a good growth of vines has invariably been made. This is especially noticeable in some of the larger vineyards in the vicinity of Weston, where the soil boundaries can be easily traced by the larger growth of vines on the coarse sandy loam, but this is probably due to better moisture conditions, rather than to differences in the soil.

Average results of mechanical analyses of samples of the Oakdale coarse sandy loam are given in the table following:

Mechanical analyses of Oakdale coarse sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
17016, 17042, 17809, 18909, 18923.	Soil.....	13.2	38.8	11.1	14.0	2.7	14.4	5.2
17017, 17043, 17810, 18910, 18924.	Subsoil.....	12.8	34.7	11.5	16.0	3.4	15.8	6.7

OAKDALE SANDY LOAM.

The Oakdale sandy loam is a chocolate-brown, medium to fine, rather micaceous sandy loam, containing a considerable proportion of coarse, sharp sand. It has been formed by a mingling of the materials giving rise to the Fresno and Oakdale soils, and has the fine material of the former and the coarse, sharp material and brown color of the latter. It is of comparatively uniform texture to a depth of 5 or 6 feet, where it may be underlain by the white hardpan of the Fresno soils, although in many places no hardpan is reached at that depth.

The surface is comparatively smooth and level. The largest body of this soil is found about 5 miles north and slightly east of Modesto. A few small areas occur in other places. In crop value it is quite similar to the better portions of the Fresno sandy loam.

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Mechanical analyses of the soil and subsoil give the following results:

Mechanical analyses of Oakdale sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18907	Soil	5.2	22.1	10.1	21.8	9.1	24.6	7.6
18908	Subsoil	5.3	22.5	9.7	19.3	13.5	22.1	7.6

OAKDALE SAND.

The Oakdale sand is a smooth, micaceous, light-brown sand or fine sand, carrying noticeable quantities of silt and clay. It is uniform in color and texture to a depth of 6 feet or more and is well drained and free from alkali and hardpan. This soil has resulted from the working over of the Oakdale coarse sandy loam by the wind, the finer material being thus collected along the lower side of the terraces on the south side of the valley and in a few other places. The surface is smooth and level or gently sloping.

The Oakdale sand is confined to a few small areas along the Stanislaus River, the largest of which lies south and east of Oakdale. It is used principally for almonds, but if irrigated would be adapted to many other crops.

A mechanical analysis of this soil gives the following results:

Mechanical analysis of Oakdale sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
17789	Soil	Trace.	11.3	25.8	45.5	5.3	8.9	2.2

STOCKTON LOAM.

The Stockton loam is a light chocolate-brown loam containing much silt and fine micaceous sand. When wet it is quite sticky and puddles easily, and upon drying it bakes hard. Under proper moisture conditions it is friable and fairly easy to cultivate. The subsoil is subject to considerable variation in texture, the soil grading in places at a depth of 12 or 15 inches into a very light loam or almost fine sandy loam which may continue to a depth of 6 feet or more. In other places the surface soil grades into a very heavy silty loam, which at about 3 feet is underlain by a lighter colored fine sandy loam or loam. The soil is free from hardpan and alkali, and in most places is well drained, though at times subject to overflow. In places a considerable quantity of waterworn gravel and pebbles is scattered over the surface and throughout the soil.

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This soil is a recent deposit along the flood plain of Dry Creek, which is an intermittent stream carrying considerable water at times during the rainy season. The soil is composed of material eroded principally from the hills which lie east of the area, and occurs as a series of narrow flats varying in width from a few rods to one-half mile or more, these being separated from the upland soils by steep terraces or bluffs rising to heights of 30 to almost 100 feet. A small area in the extreme northwest part of the survey has also been correlated with this soil.

Only a small part of the Stockton loam has been irrigated, and that by means of small pumping plants near Modesto. Under irrigation it is well suited to alfalfa, peaches, prunes, walnuts, grapes, and garden truck. The small vineyards located on it are planted principally to wine grapes, which give fairly good yields. It is believed, however, that the Tokay and other varieties of table grapes might be grown profitably and with only a little irrigation, or possibly without irrigation.

Mechanical analyses of this soil give the following results:

Mechanical analyses of Stockton loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18927	Soil	0.2	8.4	4.7	25.3	12.6	30.9	17.9
18928	Subsoil	.4	6.9	5.6	26.8	14.4	26.9	19.1

MODESTO LOAM.

The Modesto loam is a dark chocolate-brown or grayish soil containing a relatively large proportion of coarse, sharp quartz and granite sand and a very large percentage of silt. It is subject to considerable variation in texture, much of it being quite sandy at the surface, while other portions are much heavier. At a depth of about 12 inches the surface soil grades into a heavy loam or clay loam of adobe structure, also containing some coarse, sharp sand. This is underlain at a depth of 3 to 5 feet by the silty material forming the subsoil of the Fresno series, often cemented into a calcareous hardpan.

The lighter parts of this soil are free from alkali. Smaller patches of the heavier soil have an appreciable though small percentage of the injurious salts, both the black and white alkali being present. Usually the quantities are not large enough to be directly injurious to plants, but through its effects on the structure of the soil, causing it to run together and bake, it is harmful in a few limited areas.

The origin of this soil is rather difficult to determine. It seems to be the result of deposition from an old overflow course of Dry Creek, probably caused by a damming or choking of this stream

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near its mouth and by deposition from a small unnamed stream which crosses the area about 1½ miles north of Modesto. It has also resulted from fine sediments carried into this part of the valley along the old overflow channel of the Stanislaus River. This material, as is the case of the materials forming the Fresno soils, with which it was deposited, has been further modified by the action of water, the result of deficient drainage.

The surface of the Modesto loam as a whole is uneven, consisting of comparatively level stretches, marked by slight, almost circular or elongated mounds. Other parts have hog-wallow depressions, with intervening mounds, giving the entire surface a hummocky appearance. The level and higher lands are usually lighter in texture and of better depth than the lower lying and hummocky portions.

One body of the Modesto loam extends in a strip three-fourths of a mile wide from Dry Creek directly west through the city of Modesto. Another strip extends east and west a mile north of Modesto, while a third and larger body is located about 5 miles west of that city.

The lighter parts of this soil under favorable conditions are friable and easily cultivated; the heavier portions are cultivated with considerable difficulty, especially under irrigation. When wet it puddles badly, and upon drying becomes very hard.

When the crops will permit the furrow system of irrigation should be used, and each irrigation should be followed as soon as possible by surface cultivation, to prevent the escape of moisture and the formation of a crust. The soil holds moisture well, and its conservation by thorough and frequent cultivation will be found much more beneficial than frequent irrigations. This is a strong, durable soil, the heavier portions of which may be improved by the methods already recommended for other heavy soils.

Lands of the lighter and deeper phases are well adapted to alfalfa, grapes, and peaches, and may be successfully used for vegetables, berries, and, in fact, for any crop suited to the climate.

The average results of mechanical analyses of the soil and subsoil of the Modesto loam are given in the following table:

Mechanical analyses of Modesto loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
17018, 17021, 18902, 18904.	Soil.....	1.9	8.8	6.5	18.4	9.9	37.9	16.1
17019, 17022, 18903, 18905.	Subsoil.....	1.3	7.7	5.8	9.1	8.4	40.2	16.7
17020, 18906.....	Second subsoil.	1.9	12.2	7.6	18.2	7.0	39.8	8.7

The following sample contained more than one-half of 1 per cent of calcium carbonate ($CaCO_3$): No. 17020, 3.72 per cent.

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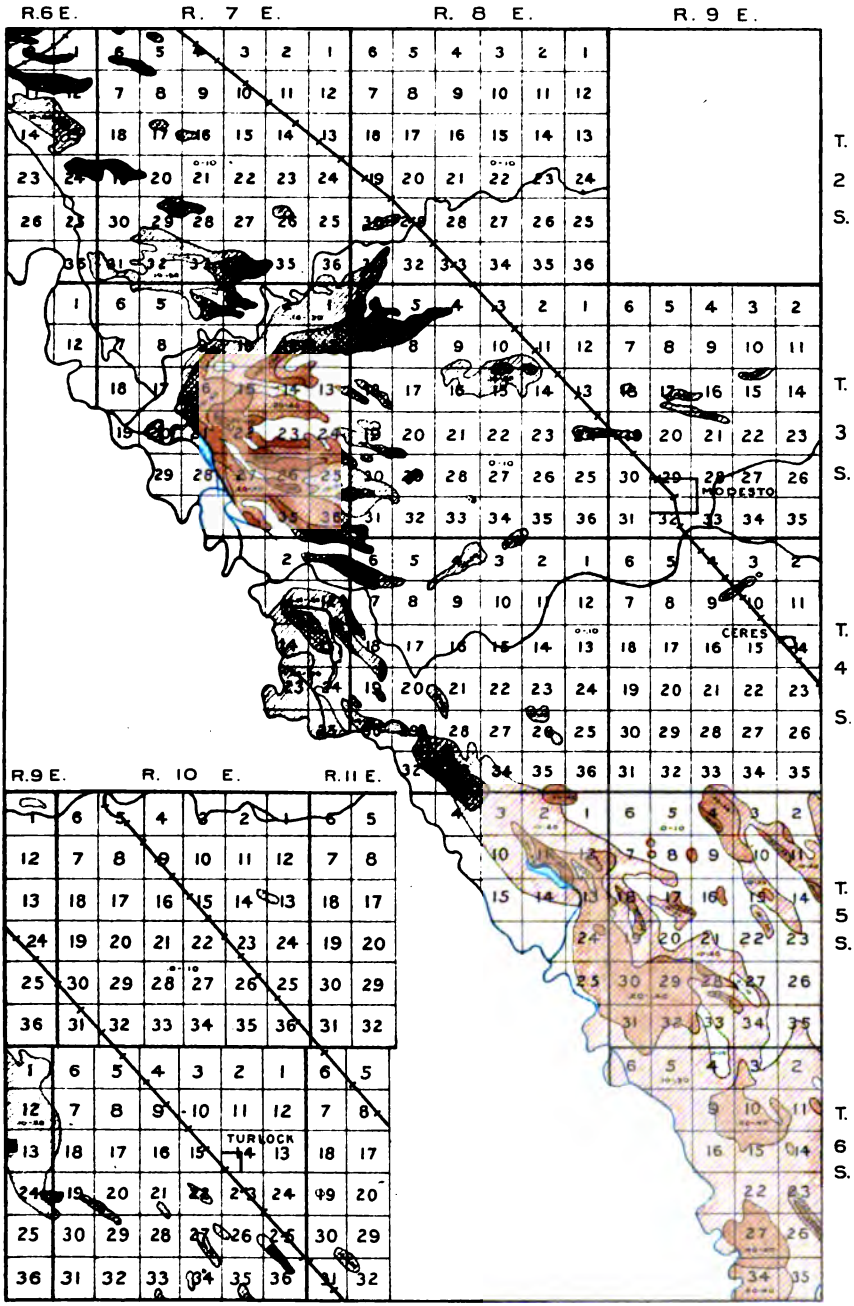

ALKALI MAP, MODESTO SHEET.

0 - .10	.10 - .20			
Less than .10 per cent.	From .10 per cent to .20 per cent.	From .20 per cent to .40 per cent.	From .40 per cent to .60 per cent.	From .60 per cent to 1 per cent.

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RIVERWASH.

Riverwash as occurring in this area consists of sand and small water-worn gravel. In depth it varies from a few inches to 6 feet or more. It occurs in small irregular bodies usually lying close to the river channels, but occasionally extends in narrow strips across portions of the flood plains. This material has been carried from the stream beds to its present position by swift currents during periods of high water. Occasionally deposits of this kind are carried into low-lying orchard or alfalfa fields, and in this way valuable land is in a single season made almost worthless. The surface of the Riverwash when first deposited is quite barren, but in time weeds and willows gain a foothold on it; but where the sand and gravel are of any considerable depth it is of little agricultural value. Some areas in which the sand and gravel are underlain at a depth of a few inches by heavier soil might be utilized for the growing of eucalyptus.

But little of this type occurs in this area, there being small bodies of it in the valleys of the Stanislaus and Tuolumne rivers, the most of which are too small to be indicated in the soil map.

ALKALI.

In parts of the Modesto-Turlock area considerable apprehension is felt in regard to the rise of alkali and its attendant evils. During the progress of the soil survey numerous examinations and tests were made throughout the entire area, and while these have indicated the presence of small quantities of alkali in many places, they have also shown that the area which is seriously affected or likely to become so is comparatively limited. In most cases the total alkali is much less than the surface appearance would lead one to believe. This is due to the fact that much of the soil has a high capillary power, which permits of the free movement of the soil moisture and the concentration of alkali at the surface. It is believed that if the causes that lead to the concentration of alkali are clearly understood and available means taken to prevent its accumulation near the surface the damage done may be confined to small areas.

The term "alkali" is commonly applied to any soluble salt in the soil which leaves an incrustation at the surface when moist soil is exposed to the air and allowed to become dry. If this salt is white, the term white alkali is applied to it, but if it becomes black or brown, as it often does around the edges of small water holes, it is called black alkali. The most common alkali salts are sodium and magnesium sulphate, sodium, calcium, and magnesium chlorides, and calcium, sodium, and magnesium carbonates and bicarbonates. Of these, the chlorides, bicarbonates, and carbonates are the prevailing salts of this area, although in places small amounts of sulphates occur.

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Sodium carbonate is a true alkali, and by its corrosive action on organic matter produces the black or brown appearance known as black alkali. It is the most injurious form, and although not occurring in all parts of the area is usually found wherever a heavy concentration occurs. The sulphates and bicarbonates are the least injurious form, but the latter may[a] by the loss of carbon-dioxide be converted into the more injurious carbonates.

It was found in this area, as was demonstrated at Fresno, that small pools of water standing on alkali soil usually contain relatively large quantities of carbonates,[a] even when tests failed to show more than a trace in the adjacent soils, the carbonates having been formed from the bicarbonates by loss of carbon-dioxide through evaporation.

Alkali comes from the breaking down of the rocks and from the further disintegration which takes place when a coarse, sandy soil breaks down into a heavier one. On the east side of the San Joaquin Valley much of these salts is believed to have come directly from the breaking down of complex silicates,[b] pyrites, and other minerals which make up these rocks, but silt and clay of volcanic origin and of the andesitic tufa which occurs along the eastern edge of the area also contain an appreciable amount of alkali, principally bicarbonates, as do also the silty material and hardpan under the Fresno soils. The salts vary in quantity from a mere trace in many places to a considerable concentration in others.

In humid regions these soluble materials have been leached out and carried away by the rain, but in semiarid regions they are dissolved a little at a time and carried into the valleys. If drainage is good, they remain in solution and are carried into the rivers and no harm is done; but if drainage is restricted, a continual evaporation results in their accumulation in injurious amounts. The filling of a subsoil and the rise of ground water to within a short distance of the surface presents ideal conditions for the accumulation of alkali. This water from its movement through the soil and from a slight softening of the hardpan usually contains small amounts of alkali. When the water comes near enough to reach the surface by capillarity, evaporation takes place very rapidly and the alkali remains at the surface.

In the area surveyed the presence of alkali is indicated at the surface by moist spots where the soil has been packed, as along the road; by bare, smooth spots on which grass will not grow and which run together and bake badly when the soil is cultivated; by the black appearance of surface water and incrustations around water holes; and by the growths of alkali weeds and salt grass.

The principal alkali lands consist of a broad, irregular strip parallel with the San Joaquin River, and of many scattered local areas,

[a] Bulletin No. 42, Bureau of Soils, U. S. Dept. Agr., p. 16.
[b] Bulletin No. 18, Bureau of Soils, U. S. Dept. Agr., p. 14.

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principally west of the Southern Pacific Railroad. In most cases these concentrations occur in low-lying areas and otherwise accompany the soil with hummocky surface and shallow hardpan. In this area the accumulations of alkali are very erratic, not extending over broad stretches, but often occurring as small spots of high alkali content, surrounded by comparatively free soils.

The areas of different concentrations are approximately outlined in Plate I. In those areas in which a concentration of 0.10 to 0.40 per cent is indicated alkali occurs in quantities not prohibitive to the growth of the more resistant crops. When more than 0.40 per cent occurs, owing to the high percentage of carbonates present, it is doubtful if any field crop can be grown.

In the alkali map considerable areas containing from 0.10 to 0.20 per cent of alkali have been outlined. Except in a few small spots these areas do not at present contain sufficient alkali to be injurious, but with insufficient drainage and other conditions favoring accumulation of alkali, such land may readily become affected to a degree that will interfere with cropping.

The effects of alkali are usually noticeable in grain and alfalfa fields by a poor, uneven stand, bare spots, weak, stunted plants, and slow growth, although such an appearance does not necessarily indicate its presence. Vines and trees when affected show signs of distress by wilted leaves, dead branches, and falling, poorly developed fruit.

The amount of alkali which any crop will stand depends very largely upon the character of the soil and the position of the alkali in the soil, a definite concentration in a rich soil or a heavy soil proving much less harmful than in an exhausted soil or in a light, sandy soil. This is probably due, in the first place, to the fact that a rich soil so abundantly supplies the plant with food that it is able to overcome the retarding effect of the alkali, and, in the second place, to the fact that a heavy soil has a higher moisture-holding capacity than a sandy one, and so the concentration of the soluble salt is really less. Alkali at the surface is more injurious than when occurring below the surface, for in this position it forms a crust which, in many instances, prevents tender plants from coming up, or, after they are up, prevents their growth by contracting the soil around the stems.

The crops most resistant to alkali are sorghum, barley, and alfalfa, when once started, and sugar beets, but these are injured by excessive amounts, depending upon the conditions stated above. Eucalyptus trees are able to make good growth on soil containing considerable alkali. Fruit trees suffer from excess of alkali. Pomegranates, figs, olives, and pears are said to be the most resistant. Grapevines[a] and citrus fruits are very sensitive to alkali.

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[a] Bulletin No. 42, Bureau of Soils, U. S. Dept. Agr., p. 19.

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The control and removal of alkali depends very largely upon the control of the ground water. This is especially true where the soils are light and have high capillary power, a condition present in a large part of the affected region of this area. So long as the ground water, even though it carries only a very small percentage of alkali, remains within 3 to 5 feet of the surface during a large part of the year, danger from a surface accumulation is imminent. Until the ground water can be lowered by drainage, or where it can not be controlled, such a concentration can be very materially delayed by using every possible means to retard evaporation. This can best be done by keeping the surface protected by a growing crop or by cultivation where not so protected.

When small local spots occur and the ground water is not near the surface, they should be well cultivated and quantities of well-rotted manure, which will improve the texture, should be worked into the soil. When irrigated these spots should be flooded thoroughly to drive the alkali down and the surface cultivated as soon after as possible to prevent its return. By this means a stand of barley or alfalfa can usually be secured on such places and these crops may be followed later by other crops.

DRAINAGE AND HARDPAN.

The most serious problem of the irrigated portion of the Modesto-Turlock area is lack of drainage.

When irrigation began in 1901 and 1903 the soils of the valley took up great quantities of water. After a few years of irrigation, however, it was noticed that the water in the surface wells of the lower portions of the irrigation districts was rising. Wells in which the water was reached at a depth of 30 or 40 feet when irrigation began were now filled to within 10 feet or less of the surface. In wind-blown depressions small lakes began to appear. During the irrigating season some portions of the fields became so soft that they could not be crossed with teams and machinery. In this way the process of filling the subsoil with water has gone on year after year. At the present time only a comparatively small percentage of the land has been seriously injured by the ground water, but the affected area has increased from year to year. In these sections injury to alfalfa, trees, and vines results not only from shallow rooting, which should be deep, but also from a fluctuating water table, which permits roots to develop during one season at a certain depth, and then by a rise or fall of the ground water either drowns them or leaves them inadequately supplied during another.

What the final outcome of this process of pouring water into the soil in the higher areas and having it come to the surface in the

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lower will be, it is impossible to determine. Some believe that since the subirrigated area as a whole is not a basin but a plain sloping to the San Joaquin and intersected by the Tuolumne and Stanislaus rivers, the subdrainage will gradually adjust itself. Others who have made a careful study of the matter believe that a complete system of drainage ditches will be necessary, and at the present time both the Turlock and Modesto districts are working with dredges on large ditches which in time may become the centers of such drainage systems.

In the meantime large crops are being grown on much of the subirrigated lands, some of the best yields of cantaloupes and sweet potatoes near Turlock and of other crops northwest of Modesto being produced without the application of water to the surface. While these yields in themselves are very gratifying, it should be kept in mind that in much of this subirrigated soil the ground water has already reached the danger point, and that its further rise in many cases means the abandonment of the land.

It would seem that a conservative use of water and a complete system of drainage are just as necessary for the highest and most profitable use of the soils of a large part of this region as is the construction of irrigation works.

Another subject very closely related to drainage, and one of interest to almost the entire area, is that of hardpan. Hardpan in the true sense of the term is not bed rock nor a material formed under water as sedimentary rocks are formed, but is a secondary product. All water which percolates through the soil soon dissolves from it soluble material of different kinds. If by any means, whether it be a change of temperature, a checking of the movement of the water, or a rapid loss of the contained gases, the water is unable to carry all the dissolved material, a part of it is deposited. Any abrupt change of soil texture might produce one or more of these causes, and as a result a part of the material carried by the water would remain near the zone of change in soil texture. Again, if soil under comparatively uniform conditions, for instance, when pastured or allowed to remain unused for years, as the soils of the San Joaquin Valley must have been, receives about the same quantity of rainfall each year the moisture will sink to about the same depth. This moisture will carry down to this depth soluble materials and leave a portion along the zone of maximum penetration and in this way a hardpan might be formed.

By one or both of these processes there has been formed under a considerable portion of the soils of the Fresno series and the Modesto loam an ashy-gray or white hardpan. Under the San Joaquin soils there is a red hardpan or sandstone. The remainder of the soils of the area either have no hardpan within a depth of 6 feet from the

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surface or are underlain by a bed rock, from which the soils have been formed. The white hardpan varies in thickness from a few to several inches; in hardness from a slightly cemented material to an indurated mass so dense that it can scarcely be broken with a hammer, and occurs at the surface of the silty subsoil which underlies the entire valley at depths ranging from near the surface to 4 feet or more.

This hardpan consists of the upper part of the silty subsoil of the Fresno soils and in some cases of the lower part of the sandy soil cemented with carbonate of lime, and usually carries alkali in varying quantities. Where it occurs at a depth of from 3½ to 5 feet or more it is very thin, easily disintegrated, of relatively low alkali content, and easily penetrated by plant roots. Here it is not harmful, and may even be beneficial in holding the moisture within reach of the plants. Where it occurs near the surface or where it is very hard it is harmful in several ways. It prevents the deep penetration necessary for the best development of trees, vines, and alfalfa. It restricts drainage even where the water table is of a good depth, often holding shallow basins of saturated soil fatal to the plants which send their roots into them. In some cases the excess of lime occurring in the hardpan is injurious. This is especially so in the case of citrus fruits where such injury is indicated by yellowing of the leaves. Irrigation and seepage waters appear to soften the hardpan in some places, but it is doubtful if much improvement will ever result from this process.

Unlike deficient drainage, the serious result of hardpan to a very great extent can not be overcome, and the surest remedy lies in avoiding shallow soil for deep-rooted crops. It is true that with irrigation under certain conditions, where thorough underdrainage is assured, vineyards may be set on soil 30 inches or even less in depth, but in the irrigated districts where the surface is comparatively level and there is danger of restricted drainage the advisability of using soil of less depth than 3 or 4 feet for orchards or vineyards is questionable, and no orchard or vineyard on soils underlain at less than 5 or 6 feet by impenetrable hardpan or ground water can be relied upon to continue for a number of years in the highest state of fruitage. Indications of shallow hardpan are usually to be seen in a hummocky, uneven surface and small, shallow depressions, these being the result of deficient drainage, but no orchardist, vineyardist, or prospective buyer should select his land without first carefully examining it with a soil auger (see footnote, p. 65). If hardpan is reached with the auger its character should be examined, which may be done along the irrigating ditches or by digging a hole for that purpose. Owing to the erratic character of the hardpan in occurring at greatly

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varying depths in a comparatively small area, it has been found impossible to outline areas of shallow hardpan without including other areas in which it occurs at greater depths.

In general the more shallow hardpan of the Fresno soils occurs under the heavier members of the series, in the western part of the area. In the south and southwest parts of the area, however, is found a large section of Fresno sand underlain by hardpan at a depth of from 1 to 4 feet. Here much of the hardpan assumes the character of a sandstone, and is several inches in thickness. In townships 5 and 6 south, range 9 east, the hardpan under certain areas is shallow and hard and in places outcrops at the surface. The selling of such shallow, alkali-impregnated soils as occur in many places in this strip to inexperienced settlers for farming purposes can not be too strongly condemned.

Underlying the red soils of the San Joaquin series there occurs a very thick, indurated, red, yellowish-red, or reddish-brown coarse-grained hardpan cemented with iron salts. This is in fact a red sandstone, probably formed under the water along the edge of the old Pleistocene lake and not a secondary product, or true hardpan. This is found at depths varying from 12 inches to 5 feet or more, but the average depth for the entire area is probably not more than 2½ feet. The nature of this material precludes the possibility of its being penetrated by plant roots to any considerable degree, or of drainage being provided except along its surface without considerable expense. The boggy nature of the red soils during the rainy season is due to the fact that the hardpan prevents underdrainage. When irrigated by the check system the same cause produces like results. When the red soils can be irrigated the border method, described under "Irrigation," which will permit of a quick but not excessive moistening of the soils, will be found beneficial for alfalfa and grain. The furrow system, with quick irrigation followed by cultivation, should be used for all other crops.

The red soils underlain by shallow red hardpan are used in some other parts of the State for citrus fruits, peaches, and vines, the hardpan being shattered by blasting; but the thickness of the hardpan, as shown in exposures along Dry Creek, the Tuolumne River, and along railroad cuts in many places in the area, makes such a method of doubtful success here; for if, instead of an outlet for drainage entirely through the harpdan, only a basin is made, this will fill with water and be much more dangerous than the unbroken hardpan. There may, however, be portions of the area in which the hardpan is much thinner than is indicated in the outcrops, and where blasting could be carried on successfully. Experiments to determine this would undoubtedly give valuable information.

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The shallow nature of much of the soil overlying this hardpan would seem to preclude its use for the growing of orchards and vines, still in some cases rather surprising results have been obtained where the hardpan is very near the surface.

On the Hickman ranch, 3 miles south of Hickman, oranges, olives, figs, eucalyptus, and other trees, as well as grapes, are planted on this soil, a part of it being of somewhat less than average depth, and these have not only made a good growth, but have given fairly good yields. In this case the oranges were irrigated, but the remainder of the orchard and vineyard received cultivation only, and not a great deal of that.

RELATION OF SOILS TO CROPS.

The soils of the Modesto-Turlock area as a whole have to a certain extent suffered from continuous cropping. When wet they become sticky and run together, and when dry they bake and form a crust at the surface. In other words, they are lacking in organic matter and are not in the best physical condition. Nevertheless, under irrigation and with thorough and careful cultivation they respond to a remarkable degree, and the growth of various crops under favorable conditions is almost phenomenal. The present need of the entire area is a system of farming which will build up rather than deteriorate the soil. The incorporation of well-rotted manure and the plowing under of green crops of alfalfa, clover, and field peas will do this. The judicious rotation of crops, where rotation is possible, must also be practiced if the best results are to be obtained.

ALFALFA AND DAIRYING.

The most important industry of the irrigated districts of this area is the growing of alfalfa in connection with dairying.

Other industries give promise of larger returns under the most favorable conditions, but none offers such good returns with the same degree of certainty. Alfalfa sown on suitable, well-prepared land yields one or two small cuttings the first season, and by the second season is ready to support the dairy herd.

Alfalfa is used, both as hay and as pasturage, almost exclusively for feed by the dairymen. It is cut greener than in many other sections of the West, being cut from 4 to 6 times a season, the best fields yielding from one-half to 1½ tons per acre at each cutting, the average for the season probably being about 5 tons. Ensilage is used to only a very slight extent, a straight alfalfa ration being considered cheaper, but corn for this purpose can be easily grown, and with the development of the industry will probably come into greater favor.

Alfalfa can be grown on almost any kind of soil, but it reaches its best development on a deep, well-drained loam, sandy loam, or silt loam. The deeper portions of the Modesto loam, the Fresno sandy

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loam, the Fresno fine sandy loam, and the Sacramento silt loam are well adapted to alfalfa. By drawing a line from a point about 5 miles west of Modesto to a point the same distance west of Turlock, thence to Denair, Waterford, Empire, Escalon, Ripon, and then to the starting point the best alfalfa section will be roughly outlined. On shallow soil or on that in which the water table comes nearer than 4 feet of the surface it may do well for a few seasons and then decline, but even under these conditions alfalfa is often found to be the most profitable crop which can be grown on land unsuited for trees or vines. Considerable difficulty is experienced in parts of the area in securing good yields on the sandier soils. This is due in part to the fact that these soils are not so well suited to alfalfa, but is also due to overirrigation and to too heavy pasturing. On the heavier soils which bake very readily spots often occur in which the alfalfa makes only a scant growth, while the surrounding plants grow vigorously. These spots are often supposed to be due to alkali, but are due very largely to a peculiar structure of the soil which causes it to compact and pinch the plants. The remedy consists in thorough cultivation by means of a spading disk or some similar implement and the incorporation of a liberal supply of stable manure or other coarse litter. The use of stable manure on alfalfa, in both the heavier and the sandier soils, will be found very beneficial. The use of gypsum on alfalfa seems to be quite general throughout this area, and is said to give good results. Its continued use from year to year is of doubtful advisability.

At present the best alfalfa land in the irrigation districts without improvements but including water can be bought at prices varying from $60 to $100 an acre. The cost of leveling, checking, and seeding by the methods used in this part of California varies from $15 to $30 an acre, depending upon the amount of work necessary.

The following interesting information has been furnished by Mr. W. P. Stephenson, 1 mile northeast of Ceres, who had 30 acres in use for alfalfa. He has 30 head of dairy cows. For the year ending November 1, 1907, the gross returns from cream, and from skimmed milk, which was fed to hogs, was $2,902.84, the difference between the cost and selling price of hogs being taken as value of the milk. Alfalfa alone was used for feed, being cut and hauled to cows which were confined to a small lot. No feed except that grown on the 30 acres was used. During the month of July alfalfa fed to cows brought $20 per ton. Calves raised were not included as a part of the above returns. The alfalfa is 5 years old, and has never declined in yield. The manure has been applied on a part of the field each year, while the remainder of the field was given a light dressing of gypsum. The alfalfa is cultivated, but is not pastured. Last year it yielded six cuttings, making 6 tons per acre.

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GRAPES.

The following table from the books of the assessor of Stanislaus County for the years 1906 and 1907 shows the interest which is being taken in the grape industry in a part of the Modesto-Turlock area. A like table for the entire area would indicate even a greater activity in vineyard planting, since a large part of the region in which the acreage is being most rapidly increased lies in San Joaquin and Merced counties.

Acreage of grape vines in Stanislaus County for 1906 and 1907.

Kind.	1906.			1907.		
	Bearing.	Non-bearing.	Total.	Bearing.	Non-bearing.	Total.
	Acres.	*Acres.*	*Acres.*	*Acres.*	*Acres.*	*Acres.*
For table	78	95	173	80	110	190
For raisins	205	219	424	250	250	500
For wine	267	925	1,192	300	2,820	3,120
Total			1,789			3,810

This table shows that in 1906 over 69 per cent of the total acreage was nonbearing, that in 1907 over 83 per cent was nonbearing, and that the total increase was over 2,000 acres. Within the area, but in San Joaquin County, in one colony south of Manteca, 3,000 acres of wine grapes in adjacent vineyards have been planted during the past two years, and another single vineyard contains 500 acres. It is the opinion of conservative vineyardists, however, that the acreage of wine grapes is being too rapidly increased, and that the extension of the industry will result in an oversupply and a corresponding reduction in prices.

The grape is adapted to great variation in soils. It may be grown with success upon heavy adobe, medium loam, or light sandy soils. It thrives best, however, on deep, well-drained soil of good moisture-holding capacity, and responds to thorough and careful cultivation.

On shallow soils grapes are often grown with considerable success; but under such conditions the question of drainage is a most important one. In level areas of shallow soil basins often occur on the surface of the underlying hardpan, which in case of excessive irrigation or heavy rainfall collect the surplus water and injure the vines which send their roots into the water-logged soil. Such injury is usually confined to small areas, and, while not entirely under control, can be relieved by providing good surface drainage and by conserving the moisture by cultivation to as great an extent as possible, thus avoiding the necessity of frequent and heavy irrigations. This precaution is especially necessary on the shallower red soils, where

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the basins seem most likely to occur. Where drainage is adequate and sufficient moisture for good growth either by means of irrigation or by conservation of the rainfall is assured, grapes may be grown on soil having a depth of 30 inches or even less.

The grape is very sensitive to alkali even in small quantities, and alkali-impregnated soils, or those which are likely to become so, should be carefully avoided in selecting locations for vineyards.

While the largest acreage of vines is on the Fresno sand and sandy loam, almost every soil in the area is used to a greater or less extent for grapes. On some of the lighter soils and on those that are heavier irrigation is used for the first year or two, after which the vines thrive without irrigation. In other vineyards irrigation is used every year, while on others, especially on the silt and clay loams, no irrigation whatever is used.

In addition to soil conditions, the three most important elements necessary for the perfect production of the grape are dry air, clear, unfiltered sunshine, and high temperature. In the San Joaquin Valley nature has provided all of these most abundantly. Under these conditions almost all varieties thrive and give large yields of fruit of good quality, yet the adaptation of varieties to soils and to localities varying slightly in climatic conditions is important. This can only be worked out as the industry develops.

The total cost for planting a vineyard on fairly level light soil, with unrooted cuttings and caring for it for the first two years, is about $30 an acre. The cost is, however, subject to wide range, depending upon the character of the land, cost of cuttings, number of cuttings to the acre, and amount of cultivation given. With varieties such as the Tokay or Thompson Seedless, which require stakes, the cost is considerably increased. The third year most varieties should produce fruit enough to pay all expenses.

The average yield for the entire State last season was about 3 tons per acre, and for the Modesto-Turlock area it should be considerably above this figure. The price of wine grapes ranged from $10 to $13 or more per ton, while of table grapes it was much higher, probably averaging $25 per ton. Very choice Tokays and Emperors bring even $60 per ton.

The net profits on grapes in San Joaquin County last year was estimated at $63 per acre.

On the Fresno sand and sandy loams, of the table and raisin grapes, the Thompson Seedless, Sultana, Muscat, Malaga, Golden Queen, and Almeria will be found well suited to local conditions. The Thompson Seedless is best suited to a deep sandy soil without hardpan, and on account of its early ripening qualities is a good variety for this part of the valley. It has the very great advantage of being marketable either as a green or dried product. The Muscat requires a rather

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heavy sandy loam and produces a fair quality of grape, but on account of lateness in ripening it is not so well suited to this section as some other varieties. Of the colored table varieties, the Black Prince and Black Cornichon are well suited to the sandy soils of the lower part of the valley. On the red soils and on the hill soils the Emperor, Flame Tokay, Black Morocco, and Purple Damascus are among the most desirable table varieties.

On the sands and sandy loam of the lower part of the valley the wine grapes Burger, Palomino Blanco, Feher Zagos, and Zinfandel are good varieties, the last named being a good bearer, though, on account of a tendency to injury by early fall rains and liability to black rot, it is not always satisfactory. On the red and hill soils the Grenache, the Alicante Bouschet, Zinfandel, and Val de Peñas will be found among the most satisfactory.

The silt loams of the river bottoms have been used to some extent for grapes and fair results with Mission, Zinfandel, and some other varieties of wine grapes obtained, but the advisability of extensive planting of grapes upon these soils is questionable.

CANTALOUPES.

During the season of 1907 there were grown in Stanislaus County 764 acres of cantaloupes, and the acreage for the present season will be greatly increased. The larger quantity is grown on the Fresno sand and the light phase of the Fresno sandy loam in the vicinity of Turlock. The largest yields and best melons are obtained from the light soils with the ground water within about 4 feet of the surface, but the growing of cantaloupes is not confined to subirrigated sections, and they may be readily grown on almost any of the lighter soils of the area.

The favorite varieties of cantaloupe in the Turlock section are the Rockyford, Klechley Sweet, Chilon, and Angelano. The first melons are ready for the market about the middle of July, following those of Imperial, Cal., and preceding those of Rockyford, Colo.

Mr. John A. Green is one of the largest cantaloupe growers at Turlock. Last year his gross returns for a large acreage was from $50 to $100 an acre, the profits depending on the crop and time of marketing. The entire cost of raising this crop, including $5 an acre rent, was about $15 an acre.

Mr. H. Fowler, 1 mile west of Irwin City, last year planted 35 acres to cantaloupes, a part of the land being too wet to produce a good crop. He began planting in April and marketed the first melons July 22. His soil is Fresno sand with ground water at about 5 feet. From the 35 acres he marketed nearly 3,000 crates of melons worth $1 a crate delivered at Turlock.

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WATERMELONS.

Watermelons are grown to a considerable extent in the vicinity of Turlock, in the section lying between Escalon and Manteca, and in other parts of the area. The soil requirements are much the same as for the cantaloupe. This crop is used extensively in the young vineyards, the melons being planted between the rows of vines. The yields in many cases have been very large and the quality of the melons excellent, but owing to lack of shipping facilities the crop the past season was an unsatisfactory one.

SWEET POTATOES.

Sweet potatoes require a loose, warm, light sandy soil for their best development. Extensive areas especially suited to their production are to be found on the lighter members of the Fresno series throughout the area, the wind-blown sand where it can be irrigated being perhaps the best suited to this crop. At present the largest acreage is in the vicinity of Turlock, but other large, though undeveloped, areas equally well suited for this crop occur in the vicinity of Manteca, west, south, and southeast of Ceres, and in the region around Delhi. Many smaller areas are to be found throughout the sections covered by the lighter Fresno soils. In the vicinity of Oakdale the Oakdale coarse sandy loam is also used for this crop and has proved fairly satisfactory. A medium-sized, cream-colored potato is grown almost exclusively.

Manuel Garcia, an experienced sweet-potato grower, who lives about 1 mile northwest of Turlock, last year received $4,000 as the gross returns from 15 acres of sweet potatoes. He received 3½ cents per pound when he began marketing his potatoes early in August and 1 cent per pound at the close of the season, the average for the entire crop being about 2 cents. Mr. Garcia says that under the most favorable conditions he raises from 160 to 200 sacks of 115 pounds each per acre.

The production of sweet potatoes in Stanislaus County for the year 1907 was estimated at 8,987,613 pounds, valued at $134,813.

IRISH POTATOES.

The raising of Irish potatoes has until recently been confined very largely to the silt soils in the river bottoms, but the lighter sandy soils are gradually being used for this purpose. Although the yields are occasionally satisfactory the crop is not a very certain one.

On 5 acres of the Sacramento silt loam, about 4 miles west of Oakdale, Mr. Walker last year raised 1,000 sacks of 120 pounds each of potatoes of excellent quality.

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OLIVES.

The growing of olives is an undeveloped industry in the Modesto-Turlock area, but one in which it is believed there are great possibilities. Olive oil and pickled ripe olives, on account of their recognized value, are rapidly becoming food staples with a large and increasing number of people, and the likelihood of overproduction is slight.

Although olive trees are to be found in almost all parts of the area, usually planted as ornamental or shade trees, the fruit of which drops to the ground or is eaten by birds, in only a very few places have small orchards been planted, and these for the most part suffer from lack of attention.

It is a popular belief that any soil is good enough for the olive, and while it is true that the tree will live under very adverse circumstances it is also true that it reaches its best development in a deep, well drained, well cultivated soil, and does especially well upon soils of granitic origin, such as are found in this area. It may be grown either with or without irrigation, but where too freely irrigated the fruit has a lower percentage of oil than where water is sparingly used. Olive trees live but do not bear well on low-lying or poorly drained soils. The lighter members of the Fresno, Oakdale, and Arnold series are especially adapted to olive culture.

Mr. A. V. Stewart, 1½ miles northwest of Ripon, has an olive orchard of 170 acres, 11 acres of which are bearing. The trees which have come into bearing are 8 and 9 years old, and last year produced 60 tons of olives, a large part of the fruit being of very high grade.

The soil is a light Fresno sandy loam or sand, with ground water at a depth of about 9 feet. No irrigation is used, but the ground is thoroughly plowed once, or, if necessary, twice each year, and then given frequent surface cultivations to conserve the moisture.

The cost of picking and delivering at the factory was about $15 per ton, and the price received ranged from $30 to $40 per ton for Mission, Oblonga, and Rubra for oil, and from $65 to $75 per ton for high-grade fruit of the Manzanillo, Savilano, and Ascolano varieties for pickling, the very choicest being worth even $100 per ton. In his younger orchard Mr. Stewart has planted his trees 30 feet apart, thus giving 48 trees to the acre, and hopes thereby to secure more satisfactory fruit both as regards quality and quantity.

The varieties most commonly raised in this part of the State are the Mission, well suited for oil or for pickling; the Manzanillo, an excellent variety ripening early and uniformly; the Savilano or Queen olive; the Ascolano, Oblonga, Rubra, and the Navadillo Blanco. On account of its late maturity the first-named variety should be grown only on light sandy soils.

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FIGS.

Scattered throughout the area, almost regardless of soils and of other conditions, may be found fig trees in various stages of growth and bearing. They seem to thrive equally well in light and heavy soils, and are often found in those that are shallow and not well supplied with moisture. While they appear to do well with these adverse circumstances, they also respond to the more favorable conditions of deep, well-drained soil and cultivation. The mere production of fruit, however, is not so important as the quality of the fruit and the conditions favorable to its proper curing.

There are in California three distinct varieties of figs, the Mission or black fig, the Adriatic or white fig, and the Smyrna fig. Of these the Mission fig is most widely distributed, immense trees of this variety being found on many of the older ranches and at Knights Ferry, La Grange, and Snelling, east of the area. Very little attention has been given to this fig and little use made of the fruit until recently, but within the last few years its excellence as a fruit, its prolific bearing, and wide adaptation to soil and climatic conditions is bringing it into favor and a few orchards of this variety are being planted.

The Adriatic fig is a smaller white variety and until the introduction of the Smyrna fig was used principally for orchard planting, the large orchard on the Bald Eagle ranch north of Modesto being of this variety. This fig is hardy and prolific, but its value is reduced to a considerable extent by a tendency of the fruit to sour on the tree, and in this respect at least it is inferior to the black fig.

Many orchards of the Smyrna fig of commerce, locally known as the Calimyrna fig, have been planted in the vicinity of Ceres and Modesto. The soil used is principally the Fresno sandy loam and fine sandy loam. Few of these orchards are old enough to bear, except in small quantities, but the growth of trees and quality of fruit produced so far are very encouraging.

It is believed that figs may be profitably grown in all parts of the irrigated portion of the area where the soil is well drained, and that they may be grown, even without irrigation, where conditions are favorable for the collecting and conservation of soil moisture.

ORANGES.

The growing of oranges here has never been considered very seriously, although a few oranges, some of them of fair quality, are produced in various parts of the area, the principal small orchards being at Modesto, at Oakdale, and in the Orange Blossom Colony, between Oakdale and Knights Ferry. In all cases a light sandy loam is used, although oranges may be grown on much heavier soil. In most cases

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the orange orchards do not receive proper care and are not well protected.

Mr. George C. Stoddard has near Modesto 5 acres of light Fresno sandy loam planted to oranges, of which 194 trees are 12 years old, 130 are 5 years old, 120 are 4 years old, and 306 are 3 years old, the larger number being Washington navel.

The past year the older trees yielded about 4 boxes per tree, and the 4-year old trees about 1½ boxes per tree. The quality was good, skin fairly thin and well colored, the fruit juicy and sweet. Picking began November 10, and the first shipment to San Francisco was made December 10, although fruit was highly colored Thanksgiving Day. The price received was $2 per box in San Francisco for sizes under 200.

ALMONDS.

The acreage of almonds has greatly increased during the last two years in the vicinity of Oakdale. The soils of the Oakdale series have been used almost exclusively for this crop, although some of the more recent plantings have been placed on the Arnold loam. Almonds do not thrive on a poorly drained soil, and the best results are obtained without irrigation. They are rather sensitive to cold, and the crop is sometimes injured by late frosts. They may be grown on any of the well-drained soils of the area, but do better in higher positions, where there is less likelihood of frost. They seem especially adapted to the deeper and sandier portions of the hill soils, and it is believed that the industry is capable of much greater extension. By the planting of more resistant and later blooming varieties, and by protecting the orchards by means of wind breaks, the profits of this crop may be very materially increased. The Texas Prolific is recommended by successful almond growers of other parts of the State as being an excellent nut, a prolific bearer, and, on account of its late-blooming habit, very resistant to frosts. The planting of this variety in alternate rows with Drakes seedlings or the Nonpareil should give desirable results. Much protection from cold winds might be secured by planting one or two rows of olives or a double row of closely planted Eucalyptus along the north and west sides of the orchards. The use of smudges and other forms of artificial protection against frost, such as are used in the citrus sections, might also be of profit.

PEACHES.

The peach requires a deep, rich, well-drained, silty or sandy soil containing much fine material for its best development. If planted on shallow or poorly drained soils it may thrive for a while, but will eventually prove unprofitable. In the Modesto-Turlock area there are a few peach orchards planted on soils less than 20 inches deep and some others in portions of which the ground water during the

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irrigating season rises to within 3 feet or less of the surface. The planting of orchards under such conditions is unwise and is almost sure to be followed by uneven, poorly developed, unprofitable trees. Signs of distress are usually indicated by slender twigs and branches and small fruit in the earlier stages, followed by "die back," rosette, sour sap from rotten roots, and finally yellowing and death.

The Sacramento silt loam along the river bottoms, the Modesto loam, and the heavier phases of the Fresno sandy loam of the upland are well suited to the production of canning peaches, the favorite varieties of which are Phillips cling, Tuscan cling, and Persian cling. For drying varieties the lighter phases of the Fresno sandy soils are deemed better. Here the Muir, the Lovell, and the late Crawford are desirable varieties. For shipping purposes the Elberta is a favorite.

OTHER TREE FRUITS.

Other valuable fruits especially suited to the heavier soils of the river bottoms are prunes and plums, but when grafted on stock suitable for the soil selected may be grown on a wide range of soils. Apricots are also a valuable crop adapted to the river bottoms and heavier sandy soils, although frequently injured by frost. Favorite varieties are the Royal and Blenheim.

The English walnut offers another valuable crop best suited to the rather loamy deep soil of the river bottoms, but by grafting on the California black walnut stock trees adapted to considerable soil variations are produced. On account of its late blooming habit, the Franquette is perhaps the best variety for this section.

The following table from the statistics of Stanislaus County for the year 1906–7 shows the leading orchard crops, as indicated by the number of bearing and nonbearing trees:

Number of bearing and nonbearing trees in Stanislaus County for 1906–7.

Fruit.	Bearing.	Nonbearing.	Fruit.	Bearing.	Nonbearing.
Apricot	32,120	38,380	Orange	18,320	12,050
Fig	55,160	130,520	Peach	64,330	266,040
Olive	27,440	14,650	Almond	28,965	52,060

SMALL FRUITS.

The production of berries is rapidly becoming an important industry of the area, the largest acreage at present being in the vicinity of Modesto, west of Oakdale, and near Turlock. Of these products, strawberries are the most important, but blackberries, logan berries, raspberries, and dewberries are also receiving attention. A loose, friable, easily cultivated, well-drained soil is best adapted to berry culture.

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ASPARAGUS AND OTHER VEGETABLES.

The growing of asparagus has received little attention in this area, but has good possibilities, the silt loams along the rivers being well suited to its production, while the growing of tomatoes, pumpkins, squashes, corn, peas, and beans for canning purposes on both the bottom and upland soils can be made a very profitable industry.

FORESTRY.

The planting of Eucalyptus is very deservedly receiving much attention in the Modesto area, where protection from the strong winds of the valley is absolutely necessary for the best development of the orchard industry, and where scarcity and high price of fuel and timber of all kinds make its use for those purposes most desirable.

At present the principal plantings are confined to wind-breaks and small groves for private use. On account of its rapid growth and towering height, the Eucalyptus excels all other trees in value for wind-breaks, and the horticultural interests of many parts of the State have been greatly enhanced by its use. Not only does it in a few years furnish a high, close protection along the windward side of orchards, but it also furnishes one which by its elastic nature directs the air currents high above the protected trees instead of breaking them into eddies and countercurrents, as a solid wall would do. It is true that some loss occurs from shading of the adjacent trees in the orchards and by the appropriation of needed moisture by the Eucalyptus, but if they are planted only on the north and west sides of the orchards and are made to root deeply the injury will be greatly lessened. For wind-breaks the blue gum or red gum, on account of its resistance to frost in the lower portions of the valley where moisture is abundant, and the sugar gum, which is more drought resistant on the higher and drier portions of the area, will be found desirable, although gray and Manna gums are also leading varieties. For wind-breaks they should be planted in double rows about 4 feet each way, the trees in one row being opposite the spaces in the other.

The planting of Eucalyptus groves on a commercial basis has been undertaken to a considerable extent in the southern part of the State and has proved very profitable. State Forester G. B. Lull says:[a] "The cost of planting large areas should not exceed $15 or $20 per acre," and "the returns on investments in Eucalyptus plantations have been generous, in many cases exceeding those received from equal areas under cultivation in orchards or agricultural crops. Groves set out in the fertile Los Angeles Valley have yielded 50 to 80 cords per acre at every cutting. Yields of 75 cords per acre every seven or eight years have been frequent."

[a] Circular No. 2, California State Board of Forestry.

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In the Modesto-Turlock area scattering trees and small groves around ranch houses are to be found thriving under almost all conditions of soil and moisture, many of these presenting striking evidence of the rapid growth of this tree even under adverse conditions.

By careful summer fallowing and using a small amount of straw mulch around the trees as soon as planted, followed later by cultivation the first season, Eucalyptus groves may be started in many parts of the area without water. In other parts occasional watering the first season may be necessary, but the Eucalyptus may be profitably grown in any part of the area. Many areas of considerable extent in the river bottoms which, on account of sandy and gravelly soils or uneven surface, are not suited for other crops but are well supplied with moisture would, if planted to red or blue gum, require little attention beyond the setting and in a very few years yield very large returns on the investment.

IRRIGATION.

Before water was obtainable from the present canal systems irrigation on a small scale had been undertaken at a few places along the Stanislaus and Tuolumne rivers, the water being brought to the land by pumping. On these places alfalfa had been the principal crop, and when irrigation on a larger scale was made possible it received first attention, and has continued to be the most extensively irrigated crop in the entire area, although other and more specialized crops are rapidly growing in importance.

Of the area covered in this survey approximately one-half is included in the Modesto and Turlock irrigation districts, 81,143 acres being in the Modesto district and 176,210 acres in the Turlock district. Four thousand acres were last year irrigated with water furnished by the Stanislaus Power and Water Company of Oakdale, while a few bodies of land north of the Stanislaus River are irrigated by private pumping plants, the water being raised from wells or from the Stanislaus River.

The Modesto and Turlock districts are irrigated with water from the Tuolumne River. This river being much lower than the country to be irrigated, the water had to be diverted at a higher point farther up its course and brought down in canals. At a point 1½ miles above La Grange, in the foothills, 22 miles east of the area to be irrigated, the Tuolumne flows through a narrow gorge between massive walls of the most resistant quartzite. At this point a dam of solid rubble masonry and concrete 127 feet high and 325 feet long was constructed, over which the river flows when its waters are not needed for irrigation. At the south end of this dam water is diverted through a long tunnel into the Turlock Canal and at the north end through massive concrete headgates into the Modesto Canal. These canals,

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one on each side of the Tuolumne River, pass through 5 miles of rough hill country, requiring heavy and expensive construction, before reaching the more level valley plain.

This system with dam, headgates, spillways, canals, and laterals, costing over $2,500,000, was built for and is owned by the landowners of the two districts.

The Modesto and Turlock districts[a] were organized under the Wright law in 1887. This law was later repealed and followed by the irrigation act of 1897. At the time the districts were organized the greater part of the land was owned by men who were engaged in extensive grain farming. The farms were large. The farmers had been very prosperous and were still fairly so, and although the yields were somewhat reduced, they wished to make no change in methods or crops. There was thus considerable opposition to the introduction of irrigation, but this was finally overcome. The main canal of the Turlock system was not completed until 1901, during which season it carried a small amount of water for irrigation. The Modesto Canal was completed in 1903 and carried the first water in the fall of the same year. Since that time there has been a steady increase in the acreage which has been brought under irrigation each year, as is shown by the following tables furnished through the courtesy of the offices of the Modesto and Turlock irrigation districts:

Number of acres under irrigation.

Year.	Modesto district.	Turlock district.	Year.	Modesto district.	Turlock district.
1901	.....	3,757	1905	10,500	(b)
1902	.....	[a] 7,000	1906	12,625	33,587
1903	.....	[a] 12,000	1907	14,000	47,922
1904	6,895	[a] 20,000	1908	29,000	[a] 57,802

[a] Estimated. [b] Records wanting.

The cost of water is based on the assessed valuation of the land, which varies from $25 to $50 an acre. The rate for 1907 is $3 per hundred on the valuation, thus making the total cost of water from 75 cents to $1.50 per acre, except in the case of small tracts with good improvement where the tax may be as high as $4 or $5 per acre.

In the Turlock district 20,000 acres were irrigated in 1904, and in the Modesto district nearly 7,000 acres were irrigated the same year. This amount has increased from year to year, but at the present time

[a] A very complete account of the development of these districts has been prepared by Frank Adams and is published in No. 3 of the Annual Report of Irrigation and Drainage Investigations of the United States Department of Agriculture.

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only about one-fourth of the entire area of both districts has been brought under irrigation.

The water used in the Modesto and Turlock districts is exceptionally pure, coming almost directly, especially during the principal irrigation season, from the melting snows of the Sierra Nevada Mountains above Hetch Hetchy Valley, and it is believed by those in a position to know that the supply is in excess of any demands likely to be made upon it for irrigation purposes for years to come.

In the Modesto-Turlock area, and in fact throughout a large part of California, the check method of applying the water is the principal one used for alfalfa, and this is used even for other crops. By this method the ground is divided into checks of convenient size, depending upon the slope of the land. These may be rectangular, or if the land is contoured, irregular. When the land is contoured lines of the same elevation are laid out at convenient intervals, and along these the soil is ridged up by means of Fresno scrapers, cross levees being located at convenient points. The soil for these is taken from the higher portions of the checks between the levees, after which the remaining irregularities are removed by filling the lower portions with earth removed from the higher. By the rectangular method all levees are constructed along straight lines, which are crossed at right angles by other levees, thus dividing the fields into rectangular checks.

The rectangular checks have the advantage of conforming to land lines, being more conveniently handled when cultivated, and of presenting a neater and more symmetrical appearance. A closely related method, known as the border system, is coming into use to some extent, and by many is found preferable to the check system. Either contour or straight borders may be used, but the evident advantage of the straight borders in most cases is so great that this method only is described. By the border method the field is laid off in long, narrow checks from 50 to 100 feet wide, depending upon the cross slope of the land. Along the edge of these checks low borders or levees not more than 12 inches high and 6 to 10 feet wide through the base are thrown up, the soil for these being removed by Fresno scrapers from the higher side of the checks, after which the surface of each check is made smooth, but with a uniform slope, the checks extending from the high to the low side of the field. A levee is constructed across the lower end of the checks, or they may be left open and the water admitted at the upper end. In many places these straight checks can be used on grades of as much as 10 feet to the mile. By the use of a large head of water irrigation can be done very rapidly and effectually, and this method seems especially suited to the loose, sandy soils of this part of the San Joaquin Valley which takes up the water rapidly and may be easily injured by overirrigation. For this reason, and because of less expense in leveling and the

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greater ease with which the low, broad levees can be cultivated and crossed with farm machinery, it would seem that this method should come into greater use.

Where the soil is not too light the system of flooding from small laterals used almost exclusively for alfalfa and grain in some other parts of the West, but almost unknown in this part of California, might be profitably introduced. By this method the surface of the land is smoothed but not leveled. Laterals from 100 to 300 feet apart, depending upon the slope of the land, are run along contours, the first one being located along the highest portion of the field. The water is then turned into one of the laterals, and near its entrance to the field thrown out by a canvas dam and allowed to pour over the side of the ditch until it has spread across the field to the upper side of the next lateral, when the dam is moved to a lower point and the operation repeated until the entire field has been watered. By this method, if the land is fairly smooth, the cost of preparing the land is very small, since only sufficient transfer of soil to secure a smooth, sloping surface and not a level one is necessary, but the labor of applying the water is somewhat greater than with the check system. The laterals are easily and rapidly constructed by a "crowder" or "go-devil." This "wild flooding," as it is termed, without retaining levees is not permitted, however, in the irrigation districts.

The cost of leveling and checking land depends so largely upon the character of the land that no very satisfactory estimate can be given, but for fairly level land not difficult to handle the entire cost, including building of levees, leveling of checks, and putting in boxes, will probably fall between $15 and $25 an acre where the check method is used. Much land in this area has, however, been checked at a cost greatly in excess of the larger amount, and on account of levees of unnecessary height and frequency has been injured for cropping. Under most conditions a field can be prepared for irrigation by the border method at a considerably less cost, while the method of irrigating from small laterals will be found still less expensive.

For trees, vegetables, vines, and berries the ditch method is used almost exclusively.

Many of the people of the irrigated portion of this area, like those of most newly irrigated sections, have made the mistake of over-irrigating. Seeing the almost magical results obtained by applying water to soil, they at once conclude that the application of water alone may be made to produce a crop, and that the more water that is applied the larger the results will be. In 1904[a] enough water entered the Modesto district near Waterford to cover the land irrigated that year to a depth of 11 feet. This amount was not all applied to the land, it is true, but that an excess of water has been and is

[a] Report on Irrigation and Drainage Investigations, U. S. Dept. Agr., 1904, p. 112.

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being used can not be questioned. The past year water was allowed to stand in many checks in alfalfa fields until the alfalfa was killed entirely or in part. If the irrigation water is free from silt, a sandy soil like that of a large part of the irrigation districts will become sufficiently moist in two or three hours and further irrigation is detrimental. While the soil is saturated the air is excluded from it and plant growth to a large extent is suspended. In addition to this, every particle of water which forces its way through a soil and down into the subsoil carries with it material needed for the nutrition of the plant.

Where the furrow method of irrigation is used, if the character of the crop will permit it, each irrigation should be followed as quickly as possible by surface cultivation to conserve the moisture and to prevent the soil from baking and cracking. Frequent cultivation following necessary irrigations will invariably prove more beneficial than too frequent or excessive irrigations.

DRY-FARMING.

For nearly half a century grain has been grown in California by dry-farming methods, and to many the term "dry-farming" means this and nothing more. In recent years, however, there has developed along the eastern slope of the Rocky Mountains, in western Kansas and Nebraska and in eastern Colorado, Wyoming, and Montana, and other semiarid regions of the West, a newer and more intensive system of dry-farming by which not only grain but also intertilled crops, such as corn, sorghum, sugar beets, and many other crops are raised, and it is to this newer method that the term is now applied.

The underlying principles of this method are the same as those upon which the summer fallow of grain land depends, and consist of three things: (1) The preparation of the ground so that all moisture which falls upon it will be absorbed by the soil; (2) the conservation of this moisture by surface cultivation, thus retaining it for the use of growing crops instead of allowing it to escape unused into the air; (3) the use of crops able to withstand drought, such as durum wheat, kafir corn, etc.

The average annual rainfall at Modesto is approximately 12 inches, at Oakdale 15 inches, and in the foothills along the northeastern part of the area probably a little more. That a large part of this is wasted in the run-off during and following a hard rain is apparent to the most casual observer. The roadside ditches filled with rapidly running muddy water, the sharp gullies washed across the grain fields, and the fan-shaped piles of sand at the base of the steep hillsides, all bear evidence of moisture lost to the farmer.

When the ground is plowed in the spring, the freshly turned surface is well filled with moisture, but so dry are the winds that within a few

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hours almost every particle of moisture has been taken from the exposed soil.

A method of farming which would catch all the moisture falling upon the soil and then hold it until needed by growing crops would greatly increase the yield, in many cases reduce the need of irrigation, and under favorable conditions make the growing of some other than grain crops possible without the use of irrigation at all. The skillful use of methods for this purpose is dry farming.

When rain falls upon soil the surface of which has been compacted as in a pasture, or in a field which has not been cultivated for some time, or even on a recently cultivated field where a dashing compacting rain has followed cultivation, much of the water runs off and is lost. This loss may be avoided to a great extent by keeping the surface loose or covered with a growing crop. During the winter season each rain should be followed as soon as possible by surface cultivation with disk or harrow, which will prepare the surface to receive the next rainfall. On steep slopes all cultivations should be across instead of in the direction of the slope.

The conservation of this moisture is based upon the principle that moisture escapes from the soil by capillarity—the same process by which oil reaches the top of a wick in a lamp—and from an uneven surface more readily than from an even one. When a soil is plowed up rough and uneven a much greater surface is exposed to the drying influences of the wind than if the surface is almost smooth. To avoid this some smoothing implement, such as a harrow, should follow the plows closely. Even then much moisture is lost by the movement of air through the spaces left along the bottoms of the furrows and to prevent which an implement known as a subsoil packer has been used successfully. This resembles somewhat an ordinary disk harrow in which small wheels with V-shaped rims take the place of the disks. These compact the soil at the bottom of the furrows but leave the surface loose. Capillarity is greatest in a compacted soil when exposed at the surface and least in a loose, dry soil, but even a loose soil, if allowed to remain undisturbed for some time, will run together and allow the moisture to escape. The crust which forms after a rain, the compacting of the surface by tramping or by rolling, and the plowsole which forms underneath the surface, all provide a means for the rapid escape of moisture. The first step in conservation, then, consists in breaking up the plowsole and in providing a smooth, loose surface-soil mulch, which if frequently cultivated will hold the moisture for the use of the plants.

Heavy silt and clay soils have much greater capacity for taking up moisture than have light, sandy soils, but when exposed they bake and crack, thus permitting of its rapid escape. On the other hand,

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light, sandy soils can not hold so much moisture, and when of considerable depth allow much of the rainfall to sink out of reach of plant roots and escape in that way. The most suitable soil for dry farming, then, consists of one of good depth, having a heavy subsoil to hold the moisture and a lighter surface soil which can be thoroughly and easily cultivated.

In that portion of the Modesto-Turlock area outside of the irrigation districts there are considerable areas to which it is believed the principles of intensive dry farming might be successfully applied. The subdividing of these lands into small holdings and their colonization as is done in the irrigated sections, however, is not recommended, or without some means of irrigation believed to be possible, and the immediate planting of trees or vines on a large scale without careful preliminary field experiments is not advised.

Many portions of the Arnold sandy loam, some portions of the Arnold loam, and a few limited areas of the San Joaquin sandy loam present very favorable conditions for growing crops by dry-farming methods. These areas can not be outlined in the soil map, for they depend much more upon the subsoil than upon the surface soil, and although during the progress of the field work hundreds of borings were made, many more would be necessary to establish the exact boundaries. The location and extent of such areas can, however, easily be determined by persons intending to use them.[a]

On selected areas of these soils it is likely that by dry-farming methods profitable crops of grapes, figs, olives, and almonds can be produced, and while the yields would probably not be large the quality would be good and the profits satisfactory. Beans, Egyptian corn, sorghum, and field peas can also be grown.

Even in those portions of the area which are abundantly supplied with water it will be found that irrigation will not take the place of thorough cultivation, and that moisture conserved in the soil is much better than moisture added to soil from which it has been allowed to escape.

REGION EAST OF MODESTO-TURLOCK AREA.

Lying east of the Modesto-Turlock area and between it and the more rugged foothill country, there is an extensive region, varying

[a] For examination of the subsoil a common 1½-inch auger may be used. It should have the central bit cut out and be welded to a one-half inch rod 3 feet long, on the upper end of which a thread should be cut. This may be attached to 3-foot sections of gas pipe five-eighths inch in diameter and a gas-pipe handle attached to the upper end. By boring into the soil a few inches, withdrawing the auger and removing the soil, a section to any desired depth may be secured. The use of a soil auger by prospective buyers, orchardists, vineyardists, and others in determining depth of soil, impenetrability of hardpan, and distance to ground water is strongly recommended.

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in width from 5 or 6 miles in the northern part to more than 20 miles at the south. Of this region a large part, on account of shallow, refractory soil and rough surface, will probably always remain a grazing country. There are, however, other portions used largely for growing grain, some of which it is believed may in time be used more profitably for specialized crops.

The topography is similar to parts of the area surveyed and consists of undulating hill lands, and farther north and east there is a considerable extent of mesa land. The mesa lands are quite pronounced west of Warnersville, where heavy beds of andesitic tufa form the resistant layers which weather into broad, flat-topped hills. The upper slopes of these hills are quite steep, but upon reaching the less resistant underlying beds they become more gradual. Though comparatively smooth the hilltops have an even, uniform slope to the west, the same beds forming the capstone of successive hills, so that at a distance they have the appearance of being a continuous elevated plain.

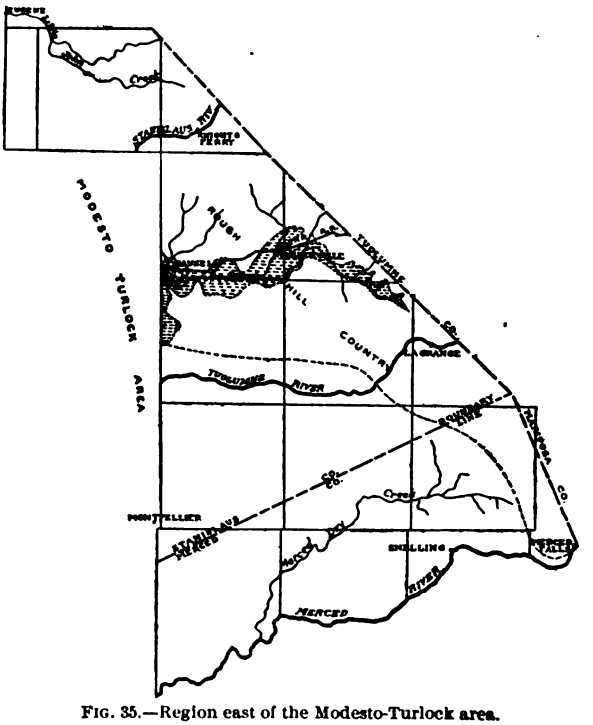

FIG. 35.—Region east of the Modesto-Turlock area.

Extending entirely across this region and into the mountains beyond are the deep, narrow valleys of the Stanislaus, Tuolumne, and Merced rivers. The region also contains the valleys of three smaller streams. The valley of Little John Creek begins near Knights Ferry on the north side of the Stanislaus River and extends northwest, entering the surveyed area at Eugene; that of Dry Creek, which heads within 2 or 3 miles of La Grange on the north side of the Tuolumne River, extends west and enters the surveyed area 5 miles northeast of Waterford; and the valley of a tributary of the Merced River, also called Dry Creek, which begins a few miles northeast of Snelling and extending west and southwest, joins the Merced Valley outside of the surveyed area.

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SOILS.

Beyond the area surveyed there is only a small amount of tillable land along the Stanislaus Valley, this consisting of a few flats of fine sandy loam and silt loam. In the valley of the Tuolumne a strip of Sacramento silt loam varying in width from less than one-fourth to more than three-fourths mile, much of it level and of excellent quality, extends to a point about 7 miles east of the surveyed area. Beyond this point the valley is considerably narrower, but still contains numerous small flats of sandy and silty soil here and there all the way to La Grange, 7 miles farther east. Along the Merced River the silt loam and sandy loam areas, varying from less than half a mile to almost 2 miles in width, extend to Merced Falls, a distance of 22 miles east of the extreme southeastern portion of the area surveyed. The soil along these three valleys is remarkably similar to the Sacramento silt loam, and, like that soil, is well suited for the growing of alfalfa, peaches, prunes, apricots, and garden truck, though injury from frost along the rivers is not uncommon.

The upland of the northern part of this region consists principally of shallow adobe soils, the underlying hardpan formation being often seen at the surface and outcropping along the hillsides. Scattered through the soil and over its surface are numerous cobbles and bowlders, the traces of an old lava flow, probably from Table Mountain. In a few places soils of a better depth and lighter texture occur, but only a very small part of this portion of the upland region can ever have any agricultural value except for grazing. Along an irregular line indicated on the sketch map, and varying from 1 to 2 miles north of the Tuolumne, the adobe hills gradually merge into hills of more uniform slope, the latter being covered with a sandy loam or loam quite similar to the lighter soils of the Arnold series already described. These hills of lighter soil extend east, north of the Tuolumne, to within 4 or 5 miles of La Grange, and then swinging south and east approach the Merced Valley between Snelling and Merced Falls. The eastern boundary, like the northern, is indefinite, the hills of more uniform slope, and soils deeper, gradually changing to those of more uneven surface and outcropping rock beds.

East of Montpellier a considerable body of the red San Joaquin sandy loam extends east and southeast to the valley of the Merced River, while in the extreme southwestern portion of this region a small area of Fresno soil occurs.

At present the larger proportion of these hill soils is used exclusively for grain, of which they produce fair yields, but it is believed that by thorough cultivation, even without irrigation, certain areas might be more profitably devoted to orchard crops.

The soil in the valley of Little John Creek is quite similar to the Stockton clay loam as found at Eugene or Farmington, there being

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about 2,000 acres in the valley east of Eugene. In the valley of Dry Creek north of the Tuolumne there are about 7,000 acres of comparatively level land, which is indicated by the shaded area on the accompanying sketch map. Of this land about 4,000 acres, principally in the upper part of the valley, resembles the Stockton clay-loam type, though lighter, and is well suited to irrigated crops and to the growing of other crops without irrigation, while the remainder is a heavy dark-brown adobe also suited to such crops but very difficult to handle when irrigated.

North of Snelling in the valley of Merced Dry Creek the soil is a yellowish loam quite similar to the Stockton clay loam, though lighter. As seen along the road between La Grange and Snelling the soil is underlain by hardpan at a depth of from 2½ to 4 feet. In the lower portion of this valley between Snelling and Montpellier is a considerable area of level sandy loam, which occurs as upland valley or bench land and resembles the Fresno sandy loam.

POSSIBILITIES OF A FOOTHILL FRUIT BELT.

For many years oranges in small quantities have been grown at Knights Ferry, La Grange, and Snelling, the fruit ripening early and being of fair quality. The most encouraging results so far obtained are at La Grange, where a little citrus garden of navel oranges, lemons, and limes is growing. The trees are thrifty and free from disease, produce fruit of excellent quality, and bear prolifically. These small orchards and the success attained in growing fruit in the foothill country in other parts of the San Joaquin Valley have led to frequent inquiry as to the possibilities of the foothills along this part of the valley as a fruit region, and especially as a citrus belt. There may be climatic conditions favorable or unfavorable to the development of such a belt which can only be ascertained by experiments; but, aside from this, the extent of available lands of suitable quality and the possibility of irrigation are factors to be considered.

The limited area of available tillable land in the vicinity of Knights Ferry or La Grange precludes the development of the fruit industry to any considerable extent at either of these places, while at Snelling there is a rather large body of rich silt loam, which is better suited to the growing of prunes, apricots, and peaches than to citrus fruits. There remains, then, a few small valleys of the minor streams, and the better portions of the foothills farther west where the growing of citrus fruits might prove a success.

The lands along Little John Creek can be irrigated from the canal of the Stanislaus Power and Water Company, and a ditch down this valley is at present contemplated. Along the main canal of this

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company there are several small, well-protected valleys which could be irrigated by water from the canal at a moderate cost. The lower portions of Dry Creek Valley, including a considerable body of level sandy loam of excellent quality and good depth within the surveyed area, numerous small sandy flats and valleys on both sides of the canal east of the area, and a considerable portion of the lower sandy foothills north of the Tuolumne could be reached by laterals and by pumping from the Modesto Canal. The upper portion of Dry Creek Valley could also be reached by a lateral from the Modesto Canal, but probably at much greater cost. The lands along the Merced Dry Creek could probably be irrigated by the storage of water near the source of that stream. A part of the valley lands along the Merced River is now supplied with water from that river. In all of these minor valleys there is a possibility of reaching underground water in sufficient quantities and at depths which would justify the cost of pumping for orchard use.

At present, water for irrigation can be obtained from the Modesto irrigation district by persons who have lands outside of the district, which can be reached by laterals from that system. For such service a flat rate of $2.50 per acre a year is charged, but the company agrees to supply water only when it is not needed in the district and makes no promises for future delivery.

The climatic conditions depend largely upon elevation, protection from cold winds, and direction of slope. The elevation of Pausell is 167 feet, of Warnerville 219 feet, and of the tillable portion of this entire region probably between 150 and 300 feet.

The average annual rainfall at Oakdale, as recorded by the Oakdale Milling Company for twenty-three years, is 15.62 inches, and at Snelling, as recorded by Mr. E. N. Neighbor for twenty-five years, is 16.04 inches.

The valleys and hill slopes are well protected, the principal slopes being to the south and southwest, so that climatic conditions seem favorable.

The orange is adapted to a great variety of soils, being grown successfully upon types ranging from a light sandy loam to a clay adobe. The success of the crop depends rather upon the conditions of heat, air, sunshine, protection from frost, and drainage than upon any particular type of soil.

From the favorable conditions found to exist it is believed that, whenever water for irrigation can be supplied, these minor valleys and the better portions of the foothills may become an important region for the growing of citrus fruits.

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SUMMARY.

The Modesto-Turlock soil survey covers an important area on the east side of the San Joaquin Valley, extending from the valley well into the foothills.

This entire area was used for many years for the production of grain, but recently water for the irrigation of a large part of it has been made available, the large ranches are being subdivided, settlers are rapidly coming in, and specialized crops are being introduced.

In the unirrigated portions of the area grain production remains the principal industry, but oats and barley are to a considerable extent taking the place of wheat. The profits are much smaller than they formerly were. Further changes will undoubtedly result either in the use of the grain ranches for grazing purposes, or in the adoption of better methods of farming, whereby the yield of grain crops can be increased and other crops introduced and grown by dry-farming methods.

In the irrigated portion of the area a great variety of crops is being introduced, and in many cases very encouraging results obtained. The dairy business is at present the most important, but will probably soon be superseded by the vineyard, orchard, melon, and truck-growing industries, which are developing very rapidly.

The soils as a whole are light, the largest part of the area consisting of sandy loams and sands. These have suffered from continuous cropping to grain. In portions of the area the soils are too shallow for the planting of deep-rooted crops, and in places they have been injured by alkali and the rise of ground water; but, on the other hand, a very large part of the area consists of deep, well-drained, easily cultivated soils, responsive to irrigation and cultivation, especially suited to vineyards and orchards, and under favorable conditions producing almost phenomenal yields of all crops suited to the climate.

Since the introduction of irrigation, the price of land has advanced sharply, but the best land is still obtainable at a low price, and considering the quality of soil, low cost of water, great diversity of crops, and advantages of close markets, probably no other area of equal size in the entire West offers greater attractions to the prospective settler than does this.

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SOIL SURVEY OF THE PORTERSVILLE AREA, CALIFORNIA.

By A. T. STRAHORN, L. C. HOLMES, and C. W. MANN.

DESCRIPTION OF THE AREA.

The Portersville area, located near the geographic center of California, about equidistant from San Francisco and Los Angeles, lies among the eastern foothills of the San Joaquin Valley. It comprises a part of Tulare County, one of the larger counties in the State, the total area being somewhat greater than that of the State of Connecticut. The area surveyed lies about half way between the northern and southern boundaries of the county. The northern end of the area is in the northern line of T. 17 S. (Mount Diablo base line) and the southern limit is the southern line of T. 22 S. The eastern boundary is very irregular, the work having been carried along the foothills to the upper limit of cultivable land and up the river and creek bottoms as far as there was any considerable area of land under cultivation. The western limit of the area is a line running south along section lines from the northwest corner of sec. 4, T. 17 S., R. 26 E.

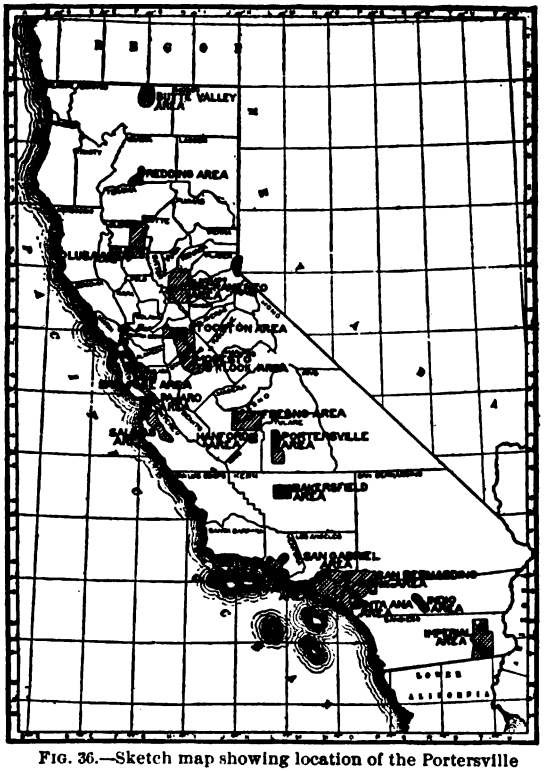

FIG. 36.—Sketch map showing location of the Portersville area, California.

The chief topographic features of this area are the broad, level floor of the San Joaquin Valley, the foothills and their slopes, and the

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interfoothill valleys following the numerous streams issuing from the hills. The greater part of the area is a sloping, gently rolling plain, extending from the abrupt slope of the foothills to the western limits of the survey.

North of the Tule River the general surface appearance is that of two broad ridges, one between the Tule River and the intermittent stream, Lewis Creek, and the other between Lewis Creek and the Kaweah River. The slope of these ridges is very slight and the difference in elevation between the crests and the bottom is hardly noticeable but is of importance as a difference of a few feet in elevation is responsible for the location of many thriving citrus orchards. South of the Tule River the general surface conditions are irregular, there being several pronounced ridges between the rivers and the southern boundary of the area. These ridges become less pronounced as the distance from the foothills increases and they merge into a stretch of level land before the western edge of the area is reached. Aside from these general topographic conditions there is a difference between the level and "hog-wallow" lands. The latter cover several thousand acres and will be considered in a discussion of the soils. The foothills rise rather abruptly to an elevation of several hundred feet above the valley and their lower slopes comprise some of the most valuable farming land in the area.

Lying back of the outer line of the foothills are several small valleys and coves which are of considerable agricultural importance, as thriving citrus orchards are found in several of them. From north to south the principal ones are Lemon Cove, Yokohl, Frazier, Pleasant, South Tule, and Deer Creek valleys.

The principal streams in the area are the Kaweah and Tule rivers and Deer Creek. The first two streams have their sources far back in the mountains and with their tributaries furnish practically the entire flow of water for gravity canals in the area. The courses of these rivers extend beyond the limits of this survey, and in times of high water their flow reaches Tulare Lake, in Kings County.

During the summer months the water in the river bed extends but a short distance beyond the foothills, either sinking into the sand and gravel or being taken out for irrigation. Deer Creek flows beyond the foothills for only a short time during the wet season, and its flow is used to irrigate a small acreage in the southwest corner of the area. Other streams are Yokohl and Lewis creeks, which drain only small areas in the upper foothills and are of little importance. Yokohl Creek is tributary to the Kaweah River, while Lewis Creek flows into a low stretch of land north of Lindsav known as Lewis Creek wash.

A small wash debouches on the plain from the northern portion of Lewis Creek and its old course may be traced nearly to Strath-

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more. During the wet season some water is found in its bed, but this soon disappears by evaporation.

The higher foothills support a scattering growth of mountain oak and grasses, the latter being used as feed for range cattle and sheep. Along the lands adjacent to the streams there is a heavy growth of willow, sycamore, cottonwood, oak, wild grape vines, and grasses. In the early days these lands were considered more desirable, owing to the heavy growth of grass which remained green long after that on the plains had dried up.

The first whites located on the Kaweah River about 1850, at a point near the western edge of this survey. This settlement was destroyed by the Indians. Other settlers followed, some to find homes along the river bottoms, others in search of gold in the mountains. Many of the latter returned disappointed and took up land in the valley.

Portersville, founded in 1864, was the first permanent settlement in the area. Exeter and Lindsay were settled in 1888, at which time the Portersville branch of the Southern Pacific Railroad was constructed.

Until the construction of the main valley line of the Southern Pacific Railroad in 1872 all communication with northern or southern points in the State was by stage. After the completion of the railroad connection was had by stages to Tipton and Tulare.

The settlement of the region has been somewhat unstable in nature, due to the changes in agricultural methods and crops. Owing to lack of rainfall the early farmers settled along the streams, where there was a supply of water for stock and domestic purposes and where the soil was capable of producing some kind of a crop without irrigation. Later, with the discovery that the arid plains would produce good yields of grain, many thousands of acres of this land were sown to wheat. Still later, when it was found that the foothill slopes and higher lands were adapted to the growth of citrus fruits a well-settled citrus belt was developed along the foothills, the industry starting in the vicinity of the towns and extending slowly outward.

The principal towns in the area are Portersville, Exeter, and Lindsay, all located near the edge of the foothills. Other settlements are Lemoncove, Naranjo, Strathmore, Plano, Globe, and Poplar. Portersville is a point of supplies for a vast stretch of country in the foothill and mountain regions. It is the shipping point for considerable lumber from the mountains, for thousands of boxes of citrus and deciduous fruits, and for grain and cattle. Exeter, 20 miles north of Portersville, is located at the junction of the Portersville and Dinuba branches of the Southern Pacific Railroad, and from here the Visalia Electric Railroad runs to Lemoncove on the east and to

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Visalia on the west. The latter town is the county seat and a prominent fruit-shipping point. Lindsay, located between Exeter and Portersville, ships a considerable quantity of citrus and deciduous fruits. A line of the Southern Pacific, known as the "Portersville Branch," which connects with the main valley line at Goshen Junction and at Famosa, furnishes transportation for the area. Through passenger service is maintained between San Francisco and Los Angeles.

The market for the produce of this area is practically world wide. The citrus fruits of this section are known in all the commercial centers of the United States, and shipments to various foreign countries are not uncommon. Other less valuable products, as hay, cattle, and dairy products, find a ready sale in the larger markets of the State.

Wagon roads throughout the area are generally good. The roads on the heavy adobe soils are almost impassable during the rainy season, but are in excellent condition throughout the summer and fall months. There is probably no other section of the State where the materials for road building are so convenient or to be had so cheaply as in this area. Rock, sand, and clay are at hand and crude oil can be obtained near by.

CLIMATE.

The climate of the area is similar to that of other higher parts of the southern interior valley—arid and subtropical.

A station of the Weather Bureau at Portersville furnishes a record of temperature and precipitation from 1897 up to the present time. The seasons are divided into the wet and dry, the former extending from about the middle of December to the middle of April. Occasional light showers occur at other times of the year, but are usually of no benefit to growing crops. The rains usually come with a southwest wind, but are rarely of a driving or destructive nature. Rains seldom continue many days in succession and there are a large number of bright days during this season. The average yearly rainfall for a number of years past is a little below 9 inches. The precipitation varies greatly from year to year, the maximum for several years past being about 19 inches and the minimum about 5 inches. Fogs are unusual, hail storms are unknown, and electrical storms are rare.

Owing to the methods followed in the farming of lands without irrigation in this section of the State, it is the local custom to base all calculations upon the amount of rain which falls during each wet season instead of the annual precipitation, since this gives the amount of rain directly affecting the crop conditions. On this basis the data show an average seasonal precipitation of about 11 inches. This amount, or even a somewhat less amount if distributed evenly throughout the usual wet season, will produce good yields of grain on the valley lands. Seasons occur, however, when the normal amount

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of rain is received, but so early in the season that the crops suffer for lack of moisture at a later stage of their growth.

The mean temperature for this section for a series of years is about 66° F., the minimum being 24° F. and the maximum 114° F., a total range of 90°. Temperatures like this are very unusual, the usual minimum winter temperature being about 32° F. and the usual maximum summer temperature about 107° F. The excessive temperature of the summer months is not oppressive, owing to the dryness of the air, and prostrations from heat are unknown. The nights are cool and comfortable throughout the summer.

According to the Weather Bureau records for nine years the date of the earliest killing frost in the fall is November 26 and the last in spring March 10. A study of the records shows that in some years there have been no damaging frosts before January 1, excepting, of course, in damp, low-lying areas, and that the last frost in the spring has occurred as early as the middle of February. In a section, however, where so many different crops are produced the particular climatic conditions of various portions of the area should be considered, since the growth of fruits ranging from berries to citrus demands different temperature conditions. A peculiarity of this area is the absence of high winds. There is scarcely a day without a pleasant breeze, but there is no record of fruit having been chafed or damaged by windstorms.

In the Portersville area, as along the entire citrus belt of the State, there are localities particularly adapted to the growth of citrus fruits, and other localities where the attempt to grow this class of fruits would be sure to result in failure. This is due largely to local topographic conditions directly affecting the difference in the temperature conditions between night and day. Wherever the conditions are such that a cold current of air flows across the land at night, it is hardly safe to attempt the culture of citrus fruits, but in localities where the warm air of the daytime is undisturbed at night or does not fall below the freezing point, citrus trees are likely to succeed. In this area, south of the Tule River, this condition of affairs is strikingly apparent. The land surface here consists of long ridges, between which there are long, broad drains, marking former stream courses. On the tops and upper slopes of the ridges the temperature seldom falls below freezing; a self-registering thermometer, on a ridge south of Plano, showing a minimum temperature of 32° during the past winter, while the temperature on the lower lands was from 6° to 8° lower. On the alluvial lands along the rivers the conditions are still more unfavorable, partly from the cold, wet soil conditions, but principally on account of the low temperatures during the nights of the winter season. However, as the available land along the foothills is now largely occupied by

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citrus groves, the alluvial lands are gradually being encroached upon, and the question as to whether groves can be made to succeed at all in such locations is a matter which will be settled by experiment in a few years. How far out into the valley the citrus plantings may be safely extended is a question upon which growers differ in opinion. The western limit of present planting is now about 2½ miles west of Lindsay, but this particular location is on the crest of a very slight ridge, rising from Lewis Creek on the north and falling away towards the Tule River lands on the south. The elevation of the crest is slight, but it is probably sufficient to place the trees in the warmer currents of air.

The minimum temperature which citrus trees can withstand depends largely upon the condition of the tree. When the tree is almost dormant it may withstand a temperature of 20° F. for a short time, with no other damage than the loss of the foliage. This temperature would be the death of a rapidly growing tree.

The damage resulting from low temperature depends somewhat upon the atmospheric conditions in the morning following a frost. A temperature of 24° F., followed by a warm, bright morning, would probably kill a tree, while the same temperature followed by a hazy morning would result in but little harm. The reason for this lies in the sudden warming of the chilled tree in the first instance and in the gradual warming up in the second.

With the advance of the citrus groves on the valley lands, the danger of damage from cold nights is increased, and should it ever become necessary to use artificial means of preventing frosts at night those interested in the subject will find it well treated in Farmers' Bulletin 104, U. S. Department Agriculture, Notes On Frost.

A summary of climatic conditions shows moderate winter temperature, high summer heat modified by the dryness of the air, an absence of high winds, hail storms or electrical storms, and a large number of sunshiny days.

The appended table gives the monthly and yearly normal temperature and precipitation for Portersville, based upon records of the Weather Bureau extending from 1897 to 1905.

Normal monthly and annual temperature and precipitation at Portersville.

Month.	Temperature.	Precipitation.	Month.	Temperature.	Precipitation.
	°F.	In.		°F.	In.
January	48.1	1.44	August	83.8	0.01
February	51.7	1.08	September	76.3	.21
March	56.8	1.39	October	64.6	.56
April	64.0	.58	November	54.9	.80
May	73.2	.58	December	48.5	1.62
June	82.5	.18	Year	66.0	8.43
July	88.1	.06			

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AGRICULTURE.

Along the bottom lands of the Kaweah River there may be found a few of the earliest farmhouses of the region. These places, however, are fast disappearing. The first farms were small and usually of minor importance to the owner, as his interest was centered in his cattle, which ranged the mountains and the valley plains. For many years these scattered farms were the only ones in the area. Then came the development of the plains, which had hitherto been regarded as valueless for agricultural purposes. It was found that these would produce grain without irrigation, and homes began to spring up on the vast level stretch of country west of the hills and there grew up one of the most important wheat-growing sections in the United States.

In the growing of wheat, dry farming is the usual practice and the seed bed is prepared by breaking the land with a gang plow which turns from 4 to 6 furrows at a time. The land is then harrowed and the seed sown broadcast or drilled in. Where exceptionally large areas are cultivated steam traction engines are sometimes used in plowing the land and harvesting the grain. The seeding is usually done in the fall and winter and the harvesting in early June. In the handling of the crop, the combined harvester, which cuts, thrashes, and sacks the grain, is used. This is drawn by from 24 to 36 horses or mules, and 5 men handle the machinery. At intervals the sacked grain is left on the ground to be picked up later and hauled to the warehouse.

The yields obtained by such farming vary from almost nothing to 15 sacks per acre, depending upon the moisture conditions of the season and the thoroughness with which the ground has been prepared. Considerable grain land is held by nonresidents and leased to farmers. The usual rental terms are one-fourth of the crop delivered at the nearest railroad shipping point.

The value of land in the grain-farming section varies from $25 to $50 an acre, depending upon location with reference to the shipping point. Within recent years portions of the grain-farming lands have increased rapidly in value, as they have proved of value for citrus fruit production.

The portion of the area devoted to grain farming is indicated very closely by the areas of the San Joaquin soils. Some grain has been grown on the higher lying adobe soils, but they are less suitable for this purpose than the lower lands.

The citrus industry caused a great change in the economic and agricultural conditions of the area and to-day forms the most important part of the agriculture. With the discovery that citrus fruits could be successfully and profitably grown, land which had been pre-

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viously regarded as of little or no agricultural value suddenly rose rapidly in price and still continues to advance as the value of these crops is realized. The arid climate requiring that the trees be supplied with water by artificial means led to a very well developed system of irrigation.

It was demonstrated by the Mission fathers over a century ago that citrus fruits would make a prolific growth in the Mission gardens where oranges, lemons, and limes were grown with other fruits and trees.

There was very little progress or development in the citrus industry, however, from the time of the early missions until about 1865, and whatever advance there had been consisted largely of small plantings to supply local demands for the fruit. In the early seventies some citrus fruit was imported to northern Pacific coast points, and these shipments brought such good prices that the citrus growers in southern California were encouraged and immediately began enlarging their groves.

It was not until the construction of the overland lines of railroad, however, that the citrus industry began its real development. At that time the orange was regarded more as a luxury than as an article of food, and these early shipments to the East brought high prices. The growers sometimes received as high as $2,000 an acre for the crop and returns of from $800 to $1,500 an acre were not uncommon. An industry which would give returns of this kind attracted thousands of growers, and the increase in the production of citrus fruits has grown by leaps and bounds, until at present the shipments of these fruits from the southern portion of the State are not far from 32,000 carloads annually.

It was formerly considered that the climatic conditions favorable to the development of the citrus industry were to be found only in southern California, but it is now well known that conditions in the Sacramento Valley are also favorable for oranges and other citrus fruits. The Portersville area was among the first to demonstrate the fact that oranges could be grown outside of southern California. How the industry has extended is shown by the annual shipments, which now reach over 2,000 cars a year, and by the present area planted, which, including young nonbearing groves, is not far from 14,000 acres.

In this area, as in southern California, the principal variety is the Washington Navel, and this variety is intimately connected with the development of the orange-growing industry in all parts of the State. In the Portersville area the Washington, Thompson Improved, and Australian Navels are the main varieties of oranges grown for market. The Washington Navel is a tree of moderate growth with a dense, dark-green, glossy foliage. The fruit is large, solid, seedless,

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smooth-skinned, and has a delicious, highly flavored pulp. The Thompson Improved Navel resembles the Washington Navel closely, although it is regarded by many as inferior in flavor and texture to the latter. It has a somewhat smoother skin and a more attractive color than the Washington, and on this account frequently commands higher market prices, particularly before the holidays. The Australian Navel is but little grown in this area, as it falls short of the other navels in color, texture, and flavor. Trees of this variety are being rapidly budded over to other varieties. The Valencia Late variety ranks next to the navels in meeting the market conditions. It is the latest shipper in the State, and does not go on the market until the latter part of May. The seedlings are a type of orange ripening between the navels and the Valencia Late. There is a rather irregular demand for a citrus fruit by the early summer market, when the navels are disappearing and before the Valencias arrive, and the improved seedlings often bring good prices. The Mediterranean Sweet, Joppa, and Parson Brown are the principal varieties of improved seedlings grown in this area. These fruits average somewhat smaller than the navels, are lighter colored, have few seeds, and are inclined to have thick skins.

The growing of lemons has not received the care or attention that oranges have received, and hence are much less grown. In the selection of suitable climatic and soil conditions for the production of oranges, it has been found that there are more extensive areas where the lemon can be successfully grown than was formerly supposed. The varieties of lemons grown in the Portersville area are the Eureka, the Lisbon, and the Villa Franca.

Aside from the fact that the lemon requires a larger amount of irrigation water than the orange, due to its habit of continuous bearing, the methods of planting and cultivation are very similar. In this area there is but little difference in the way the two trees are pruned. The sucker growth and deadwood are removed each spring, the aim being to get a well-shaped tree with a small mass of foliage to protect the tree and fruit from sunburn.

The picking season for the lemon in this section runs from September to the latter part of April. The fruit is picked according to size, without regard to color, as the fruit will color up during the curing process. Throughout the entire operation of picking, handling, curing, and packing the lemon the utmost care is required to avoid injury to the fruit, as its softer skin makes it much more susceptible to bruising and rotting than the orange. When the lemons are removed to the packing house they go through a process of curing, which puts the fruit in a better condition for the market by hardening the skin and making the pulp jucier. Some grapefruit

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is grown in this section, but the amount shipped is small, as most of the fruit is consumed in the area.

Although most of the citrus trees now planted are supplied by nurserymen, many owners of groves in this area grow trees either for the extension of their own groves or to supply their neighbors.

Whatever the texture of the soil may be, the ground for the orchard is plowed at least 12 inches deep if possible and thoroughly harrowed and dragged. In this area the rectangular system of planting is used very largely. Orange trees are planted either 20, 22, or 24 feet apart, making 108, 90, or 76 trees to the acre.

The cost of planting a citrus orchard and bringing it into bearing depends upon the conditions affecting individual growers, the cost of the land, leveling, cost of water, how much labor is hired, and the cost of maintenance, which increases from the time the trees are set out until they come into bearing, all varying widely. Below is a statement of the estimated maximum and minimum cost for which a 10-acre grove can be planted and brought into bearing. It is believed that these figures represent both extremes of the cost at the time of making the survey (1908).

Item of cost.	Lowest.	Highest.
Land with water (10 acres)	$1,000	$1,750
Trees for the same	810	1,080
Cost of planting	100	100
Tree protection and replants	15	30
Water for six years	180	600
Care for same time	1,000	1,500
Total cost	3,105	5,060
Average	$4,080	

At the end of six years, assuming average yields and normal market conditions, the income from the orchard should amount to about $3,250, making the total cost of the orchard up to this time about $830, with possession of a property worth at least $6,000.

In the matter of the adaptation of citrus fruits to soils, it may be said that there are no restrictions with regard to the texture of the soil itself, although other local conditions, like standing water within several feet of the surface, low, heavy, damp ground, and alkali, may unfit a soil for the growth of these trees. In the Portersville area the soils consist of alluvial sandy loams, sedimentary sandy loam, loam, and adobe, and residual sandy loams and residual adobe.

The early orchards were planted on the heavy clay loam adobe (Portersville clay loam adobe) along the hillsides and higher slopes, as it was supposed that the lower, flatter valley soils were unsuited for this crop. Aside from the adobe soils, the largest acreage of

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orange groves in the area is found on the "red soils" (San Joaquin series). In texture these soils range from a sandy loam to a clay adobe, the lighter textured soils being most extensively planted at present. Orchards are being planted on the heavier red soils, however, and are proving successful. These red soils are underlain by hardpan. At one time it was thought that orange groves could not be grown upon land underlain by hardpan. This, fortunately, has not proved to be the case in the Portersville area. In this area, when the hardpan is within 5 feet of the surface, it should be, and usually is, broken up by the use of giant powder, and the efficacy of this treatment is evidenced by the large acreage of healthy trees.

The breaking up of the hardpan is necessary, as it is the only means of giving the trees a good underdrainage. After irrigation, the excess of water in the soil rests directly above the hardpan, and unless the latter were broken up so that the water may drain away, the roots of the trees would be injured. If the hardpan is underlain by a heavy impervious clay, however, the breaking up of the hardpan might not accomplish much good for the trees.

In cases where the hardpan proves to be only an inch or two in thickness, it is broken by crowbars and removed, powder being used only where it is several inches in thickness. The cost per acre of blasting this hardpan varies with the thickness, but usually the price ranges from 5 to 15 cents a hole.

All of these red soils have a more or less uneven surface, locally known as "hog wallows," which is characteristic of this class of soils. The surface consequently requires leveling before trees are planted, or irrigation is impossible. The cost of leveling varies from $20 to $35 an acre.

Irrigation is necessary for the successful cultivation of citrus fruits in California, and in this district sufficient money has been expended to construct excellent irrigation systems. The furrow method or a modification of it seems to be the most satisfactory mode of applying water to the groves in the Portersville area, and in the young orchards this method consists of running furrows 3 or 4 inches deep on each side of the rows of trees, and from 12 to 18 inches from the trees. As the trees become older, the furrows are placed farther from the trees and are made deeper. When the orchard reaches bearing, three laterals, usually 10 or 12 inches deep, are run between each row. The aim is to place the moisture as far down in the soil as possible, and to secure a deep root system for the trees. If the water is applied in shallow laterals near the surface, the young roots of the tree are drawn toward the surface and may be injured by cultural operations or by a drying out of the surface. The total amount of water applied is practically the same for both the light and heavy

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soils, although probably the irrigation is somewhat heavier on the lighter soils, as these soils absorb water more rapidly.[a]

The number of irrigations which the orchards receive during the growing season is dependent largely upon the length of the dry season, but will run from four to six.

Each irrigation is followed by a thorough cultivation as soon as the soil is dry enough to permit handling. On the lighter soils cultivation may sometimes begin the day following the application of water, while on the adobe soils cultivation is seldom attempted until four to six days have passed. Care is always taken to keep the water from the trunks of the trees, as scalding, foot rot, and gum disease may follow.

In this area the larger number of pumping plants are operated by electric power. The cost of irrigating citrus orchards in this way varies from $5 to $30 a year, depending upon the total height to which the water is lifted.

In this area a cover crop of native vegetation or planted legumes is maintained throughout the winter season while the trees are dormant, or nearly so. The cover crop may be either cowpeas, vetch, bur clover, grain, or weeds. In the spring it is turned under and the ground is made thoroughly clean.

After plowing a heavy disk harrow is usually run two ways of the field so as to cut up the rank vegetation and to put the soil in good tilth. As a rule, nothing more is done until time for irrigating, except occasionally where a second disking may be necessary. It is the common practice to cultivate as soon as possible after applying water, for this prevents the soil from baking and tends to conserve the moisture in the soil by creating a loose mulch on the surface. This mulch should be at least 6 inches deep. The cultivation should extend as close to the trees as possible without injury. After each irrigation the operation is repeated, and it is the common practice to give the ground under the trees a thorough hoeing at intervals during the summer, so as to keep the soil in a loose condition and to remove all weeds. This process is kept up until October, when the cover crop is allowed to start.

A considerable amount of commercial fertilizer is used in the citrus orchards of the area. Usually there is an abundance of lime in the soil and the ingredients needed are phosphoric acid, potash, and nitrogen. The grower has a great variety of brands from which to select. In some cases the growers have the fertilizers prepared according to formulas which they furnish fertilizer companies. In general, the tendency is to use a fertilizer high in potash and low in nitrogen, the accepted idea being that an excess of nitrogen increases

[a] Evaporation Losses in Irrigation and Water Requirements of Crops, Bul. 177, Office of Experiment Stations, U. S. Dept. Agr.

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the pulp and thickens the skin of citrus fruit, while potash is believed to aid in maturing the fruit.

Upon the heavy adobe soils some groves show yellowing of the leaves during the wet season and regain their normal color with the coming of the spring. In these cases the trouble is due to the location of the grove, the land being rather poorly drained and becoming water-logged during the rainy season. The fact that the trees recover when the soil is warmed and dried suggests the use of drains as a remedy.

In the adobe areas a light-colored compact layer is sometimes found at 3 to 6 feet below the surface. This compact layer was found on analysis to contain from 1½ to 13 per cent or more of lime, together with 0.3 to 4 per cent of magnesia. This may be classed as being very nearly a lime hardpan, and it is too compact to be penetrated by the roots, although it is possible to bore into it with the soil auger. In nearly all cases where this hard stratum is present the trees show signs of deteriorating. This deterioration is seen in the yellowing of the leaves and decrease in growth at the tips of branches. It is called "chlorosis" of the citrus, and is due to an excess of lime in the soil. In such locations the soil has become water-logged. Placing of tile drains in these localities would draw out of the subsoil the excess of soluble lime which injures the trees. Frequent irrigation coupled with efficient drainage would undoubtedly overcome to a considerable extent the yellowing of citrus trees. Planting of wind-breaks of olives, figs, or other trees about citrus groves has proven very effective as a frost protection, especially in the groves lying far out on the valley floor.

The season of picking oranges extends over several months. The Washington Navel is picked in November and the gathering of the fruit continues until late in February; seedlings are picked from late December to about May 1, while the Valencias follow immediately after the seedlings and run until the latter part of June.

Lemons are picked from September to May. The fruit is handled by a local association, which assures uniform methods of packing and selling at the lowest possible cost to the grower. This plan of marketing has been very successful, and the grower is now assured that his crop will be packed and marketed at the lowest possible cost, and that it will be sold to the best advantage in the eastern market.

The net returns vary widely with the age of the trees and with the care given to the grove. A grove in full bearing and in good condition should net the owners on an average about $275 an acre, and many orchards net close to $500 an acre.

The total area planted to citrus fruits at the time the area was surveyed was about 12,300 acres. Each year there is considerable

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increase in the acreage. Taking $600 as the average value per acre this gives a valuation of nearly $8,000,000 for the area in these orchards.

The general soil and climatic conditions in this area are favorable to the growing of several species of the Eucalyptus, and as the supply of timber is decreasing rapidly and the price increasing, the planting of this tree ought to be encouraged. It has a rapid upright growth and requires no care after the second year.

The acreage planted to grapes is fast increasing, the largest plantings being in the vicinity of Exeter and extending southward around Lindsay and Portersville. The principal varieties grown are Muscats, Emperor, Thompson Seedless, and some Tokay and Malaga. As in all other fruit culture, in this section a thorough cultivation of the soil is the rule. The ground is plowed deeply and thoroughly harrowed after each irrigation. Practically all of the vineyards are planted on San Joaquin sandy loam, there being but a scattered acreage on several other types of soil. Irrigation is necessary and the water is secured almost entirely by pumping from the underground supply. The furrow system of irrigation is used. The vines are pruned early in the spring before the flow of sap commences. The waste wood is either hauled away in wagons to be burned, or is burned in the field in a portable sheet-iron furnace drawn between the rows. Raisin grapes yield from 1 to 2 tons of raisins per acre, and usually net the growers about 3 cents a pound.

On the alluvial lands along the Tule and Kaweah rivers and to a certain extent on the lighter San Joaquin soils some deciduous fruits are grown. Apricots, peaches, prunes, and plums are produced. In these orchards, as in other fruit sections, the cultivation of the soil is thorough from the beginning of the dry season to the end.

Peaches are either shipped to one of the large canneries in Visalia or to one of the packing houses, where the fruit is packed for the eastern markets. Prunes are usually dried on trays spread out in the field. The fruit is sold by the farmer either on the tree, to be picked and dried by the buyer, or the dried fruit is sold to the packing house directly. These fruits are always grown under irrigation.

As yet olives are not grown upon a commercial scale. The trees are planted for wind-breaks around orchards and groves. Judging from the healthy appearance of the older trees, it is believed that olives could be profitably grown commercially. Berries and other small fruits are not yet grown to any extent, although small plantings occur near the larger towns of the area. The larger proportion of this class of fruit consumed locally is shipped in by rail. It is believed that the production of berries to supply the local demand would prove profitable to the owners of small farms.

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The alluvial soils along the river bottoms are well adapted to alfalfa and the acreage of this crop is increasing rapidly. On account of the high water table irrigation is not absolutely essential. The yields, however, are somewhat increased by irrigating the fields after each cutting. The crop is cut from three to five times each year, yielding about 1 ton to the acre at each cutting. The selling price of the hay varies considerably, depending upon the supply of native hay at the time and whether it is sold loose or baled, ranging from $5 to $15 a ton. A large proportion of the alfalfa is grown by owners of dairy herds as a feed for their stock.

The dairy business is increasing rapidly. Two creameries now running churn close to 4,000 pounds of cream each day, the product supplying the home market and going to San Francisco and Los Angeles. The farmers are paid for their cream according to the proportion of butter fat it contains, and the price varies from 20 to 33 cents a pound, depending upon the ruling quotations for butter.

Data taken from the United States Census of 1900 show the total acres in farms in Tulare County to be 1,059,727, of which over 50 per cent is improved. The value of farms and improvements (except buildings) is stated as $15,898,600. Since these figures were compiled the increase in value of farms has been enormous. No figures are at hand for the entire county, but in the Portersville area (less than 10 per cent of the entire county) a very conservative estimate of the value of the citrus groves alone is $10,000,000.

In this area there is a decided tendency toward small farms. Large holdings were formerly the rule throughout the area, but many of these are now being cut up into 10, 20, and 40 acre tracts, at prices ranging from $50 to $200 an acre, depending upon the proximity to towns and the crops which may be produced.

The general trend of land values is upward, although the prices asked are seldom out of proportion to the earning value of the soil.

SOILS.

The soils of the Portersville area fall naturally into three groups, each of which is distinct as to topographic position, manner of formation, and crop adaptation. This division is made primarily upon method of formation, the groups consisting of residual soils, or those derived through the weathering of rock in place, lacustrine soils representing sediments laid down in the quiet waters of lakes, and alluvial soils formed from deposits spread out over their flood plains by streams.

The residual soils are confined to that portion of the area usually referred to as the foothills and also to the low, narrow ridges which sometimes project from the foothills into the valley. These soils

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occur in the highest portions of the area, and are formed directly from the decay and weathering of the underlying granitic and metamorphic rocks. The texture of the soils and the surface slope are such that there is usually good drainage. The soil mantle is deep and the underlying rocks are seldom exposed except in spots where erosion has been excessive. The following are the soil types of residual origin: Portersville clay loam adobe, Portersville loam, Portersville coarse sandy loam, and Rough stony land.

The second group of soils, or those of lacustrine origin, are included in the San Joaquin series found upon the lower foothills and the upper slopes of the valley. They occur at a somewhat lower elevation than the residual soils, and merge imperceptibly into the alluvial or Hanford series of soils at a still lower elevation. The material from which these soils are derived was deposited in the bottom of an inland lake during Pleistocene time. Weathering and erosion has since modified these old deposits to a considerable extent. All of the soils of this class are usually underlain by an impervious hardpan at depths varying from 1 to 5 feet. The surface is often rather flat and covered with "hog wallows" and small, low mounds, and both surface drainage and underdrainage are deficient. The following are the soils which belong to this class: San Joaquin sandy loam, San Joaquin loam, and San Joaquin clay adobe.

The soils of alluvial origin are found along all of the main stream courses in the lower parts of the area, where during the flood season the water usually leaves the stream banks and spreads out over the flat lands adjoining. The sediments carried down from the mountains and higher ground are spread out over the bottoms in thin layers during flood time. Nearest the stream, or wherever the current is swiftest, the coarser grades of sands and gravel are deposited, and hence the origin of the coarser textured soils. Farther away from the stream, or wherever the current is sluggish, the finer sediments, like fine sands, silt, and clay, are deposited, giving the finer textured soils. The following are the alluvial types in the area: Hanford sand, Hanford sandy loam, Hanford fine sandy loam, Hanford loam, Poplar fine sandy loam, Exeter sandy loam, Lewis clay loam, and Riverwash.

During the progress of the survey a careful examination was made of each soil type to determine the quantity of alkali present. With two exceptions, the soils are comparatively free from injurious salts, and no anxiety need be felt upon this score. In the Lewis clay loam northwest of Lindsay there is an average of from 0.40 to 0.60 per cent of alkali in the first 6 feet, and 4 miles west of Portersville there is another small strip of land which contains about the same quantity. Both of these areas are small and unimportant, and are covered by the characteristic alkali vegetation, such as salt grass, ink

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weed, and greasewood. Over the rest of the area, wherever small accumulations of alkali occur, the salts are practically all concentrated within the surface 2 or 3 inches of the soil.

The following table gives the names and extent of the many types of soil mapped in the Portersville area:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
San Joaquin sandy loam	72,960	34.6	Lewis clay loam	3,776	1.8
Portersville clay loam adobe	32,832	15.6	Portersville coarse sandy loam	3,392	1.6
Hanford fine sandy loam	22,848	10.9	Riverwash	2,688	1.3
San Joaquin loam	20,992	10.0	Exeter sandy loam	2,240	1.1
Rough stony land	14,528	6.9	San Joaquin clay adobe	1,984	.9
Hanford sandy loam	9,664	4.6	Hanford loam	1,600	.7
Portersville clay adobe	8,064	3.8	Hanford sand	1,472	.7
Portersville loam	5,888	2.8			
Poplar fine sandy loam	5,632	2.7	Total	210,560	

HANFORD SAND.

The Hanford sand consists of 6 feet or more of a light-brown or buff-colored micaceous sand. The lower lying areas of this type near the streams frequently have a thin covering of heavy fine sandy loam, or silt, deposited by the river at times of overflow. The texture of the subsoil below 18 or 20 inches is subject to considerable variation, owing to the occurrence of alternating layers of fine and coarse material deposited by the shifting currents of the stream. This soil occurs in elongated areas along the courses of the Tule and Kaweah rivers, and in the courses of former stream channels between the Tule River and Deer Creek. The total area is small.

The surface of this soil is usually somewhat cut and gullied by streams, although in higher locations it has a very level surface. Owing to its loose, porous nature the drainage is generally good, the exception to this being largely in the old stream channel just south of Tule River and west of Plano, where the surface is little above the level of the river and where there is more or less standing water throughout the year.

This type is one of the more recently formed soils, and in the lower lying areas additional material is being deposited annually during periods of high water. The soil is of alluvial origin, and the larger portion of the material has been derived from the erosion and weathering of granite rocks in the mountains to the eastward.

Traces of alkali are present only in the poorly drained portions of the type. The salts are concentrated on the immediate surface of the soil, due to the continued evaporation of water from the high-

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water table. These alkali areas are of no importance, as they are too wet for cultivation.

Near the courses of the present streams this soil supports a heavy growth of cottonwood, willow, sycamore, and underbrush. Along the courses of the old stream channels the type is treeless and supports a thin growth of grass during the wet season.

But little of the type is under cultivation. Portions of the long, narrow strip extending northwest from Deer Creek are dry farmed to grain along with the adjoining land, but unless the season is unusually wet scarcely any grain is produced. A part of this type along the Kaweah River north of Exeter is planted to potatoes, and a yield of from 100 to 150 bushels per acre is secured. The water table is but a few feet below the surface and the crop is produced without irrigation. The soil is generally deficient in organic matter, and if it is to be cultivated extensively additions of organic matter either in the form of stable manure or green manuring crops will be required to maintain its productiveness. In the higher and better drained locations it is believed that early truck crops would succeed. On account of its position it is subject to frosts, and the growth of fruits would be attended with considerable risk. North of Poplar there is a small area of the type that is higher and better drained, and here it is believed that various stone fruits, alfalfa, or truck crops would prove successful under irrigation.

The following table gives the results of mechanical analyses of soil and subsoil of the Hanford sand:

Mechanical analyses of Hanford sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18697	Soil	14.1	52.5	13.4	11.2	1.8	5.4	1.5
18698	Subsoil	23.8	37.4	8.9	7.3	7.0	12.2	3.7

HANFORD SANDY LOAM.

The Hanford sandy loam is a light-gray or buff-colored micaceous sandy loam, with a depth of 6 feet or more. Considerable quantities of fine whitish gravel are often present. Below 48 inches the sandy loam occasionally grades into a yellowish-brown, sticky loam. This type usually contains enough silt and clay to make it somewhat sticky, and if cultivated when too moist it breaks into hard clods, but if handled at the right time it is easily cultivated. The type varies somewhat, approaching sometimes the Hanford sand in texture, and where these two soils are in contact the boundary line is usually indefinite. North of the St. Johns River the soil is usually underlain by a

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red hardpan at varying depths below 5 feet. This soil occurs as elongated or irregular bodies associated with the alluvial soils along both the Tule and Kaweah rivers, and north of the St. Johns River. The total area of this type is 9,664 acres, or about 4.6 per cent of the area surveyed.

Having a level and uniform surface, little or no work is required to prepare the land for irrigation. During the wet season in those portions of the soil nearest the rivers the level of the underground water is frequently within 3 feet of the surface, but it soon falls to a depth of several feet with the lowering of the water in the streams.

The Hanford sandy loam is alluvial, having been formed largely of granitic material from the mountains reworked and deposited by streams during floods. Along the Tule River on the north traces of alkali are generally present, but the quantity is not sufficient to warrant mapping. The alkali is found concentrated in the first inch or two of the surface soil, where it has accumulated through evaporation of water which collects in these spots. In the immediate vicinity of the streams this type is usually covered with a dense growth of trees and underbrush. Farther away the type supports a growth of native grasses and occasional groves of valley oak. When cultivated and irrigated, good yields of grain and alfalfa are secured and deciduous fruits and grapes do well. A limited acreage of this soil is dry farmed to grain, giving about the same yields as are obtained in the dry grain districts. A large percentage of this soil is used for pasture. This is due not to any lack of productiveness of the soil, but for the reason that some of the land is held in rather large tracts and that some of it is not reached by any irrigation system at present.

The following table gives the results of a mechanical analysis of the soil of this type:

Mechanical analysis of Hanford sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18699	Soil	7.6	25.1	12.9	34.3	7.1	10.2	3.0

HANFORD FINE SANDY LOAM.

The Hanford fine sandy loam consists of 6 feet of light-brown or buff-colored, very micaceous fine sandy loam. Along the immediate stream courses the subsoil is sometimes stratified with finer or coarser material. Below 6 feet the soil usually grades into a heavy loam, but near recent drainage courses it is usually underlain by sand and gravel. Very narrow strips of Hanford sand are sometimes asso-

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ciated with the type. The type is alluvial in origin and occurs principally along the Tule, Kaweah, and St. Johns rivers. Small, narrow bodies are found along Yokohl, Lewis, and Deer creeks.

The topography of the type varies. In the river bottoms, where it is subject to overflow, the surface is frequently broken and is more or less cut and gullied. A part of the area along the St. Johns River was at one time protected by a levee, but this levee has not been kept in repair and at present the soil is overflowed each season. The higher lying areas are generally level, but leveling is sometimes required before the land can be irrigated. The soil drains readily when the conditions are favorable and the higher portions of the type are free from standing water.

Along the streams the water level is within a short distance of the surface and the land is wet throughout the greater part of the year. Drainage of the type in such locations is hardly practicable, as they are too near the level of the streams.

This type, like the other alluvial soils of the area, is made up largely of wash from the granitic mountains and foothills, which has been subjected to the assorting action of water and deposited during flood times upon the lowlands.

Alkali is nearly always present in this soil, but usually in quantities less than 0.20 per cent in the upper 6 feet of soil. The alkali is concentrated near the surface and below that the soil is practically free. West of Portersville, however, there is a small area where the alkali averages from 0.40 to 0.60 per cent, and here the distribution of the alkali salts is nearly uniform throughout the soil to a depth of 6 feet.

This type was originally forested with a heavy growth of cottonwood and adjacent to the streams it supported a dense growth of willow, sycamore, vines, and underbrush. A considerable portion of the native vegetation is still standing.

A limited area is under cultivation; the greater part of this is irrigated with water drawn from some of the canals in the vicinity. The problem of obtaining sufficient water is a very serious one, as the streams go dry during the summer. The supply should be supplemented by pumping from shallow wells, as the water table lies within a short distance of the surface. The Hanford fine sandy loam is devoted largely to pasturing stock and dairy cattle. The yields of grain, alfalfa, corn, potatoes, grapes, berries, and deciduous fruits are good.

A phase of this type, consisting of from 24 to 54 inches of a light-brown micaceous fine sandy loam, underlain by a coarse whitish river sand, occurs in long, narrow areas along the Tule River west of Portersville. The surface is fairly level, although occasional low

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swales are found, and adjacent to the river the surface is usually cut by flood channels. The subsoil represents depositions of an old stream, while the surface soil is more recent alluvial material weathered from the granites of the mountains and washed down by the streams to lower levels.

No harmful accumulations of alkali are present in this phase of the type. The native vegetation consists of a heavy growth of cottonwood, willow, and underbrush. The treeless portions afford good grazing. Practically none of it is under cultivation. It is used largely for pasture.

The following table gives the average results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Hanford fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
18701, 18702, 18703,		*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18723, 18725	Soil.....	2.3	5.8	2.0	22.2	22.3	38.0	6.8
18724, 18726	Subsoil	12.9	25.1	10.5	18.5	8.9	18.9	5.1

The following samples contained more than one-half of 1 per cent of calcium carbonate ($CaCO_3$): No. 18701, 3.49 per cent; No. 18702, 2.30 per cent.

EXETER SANDY LOAM.

The Exeter sandy loam consists of 6 feet of dark or reddish-brown coarse sandy loam usually containing considerable fine gravel. The soil materials are mainly the wash from areas of the red San Joaquin soils, with smaller additions of wash from the soils of the Portersville series occurring in the adjacent hills. A relatively large proportion of clay and silt is usually present, and this makes the soil sticky and gives it a tendency to bake in hard clods if cultivated too soon after a rain or after irrigation. Along the boundary line between this type and the soils of the San Joaquin series the compact red clay or hardpan of the latter is often encountered in the lower depths, indicating that the Exeter sandy loam has been deposited at a later date than the soils of the San Joaquin series.

This type occurs north of Exeter. Its surface is remarkably level, little if any work being required to prepare the land for irrigation. Although the soil is somewhat sticky, it allows a ready passage of the water and permits cultivation soon after irrigation. The level of the ground water is usually below 25 feet. This soil is an alluvial deposit, and represents a former course of Yokohl Creek.

This type is entirely free from alkali, and is dry farmed to a small extent to grain, but its chief value lies in its adaptation to citrus fruits, and to grapes, peaches, and other deciduous fruits.

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The following table gives the results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Exeter sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18695	Soil	4.3	17.1	7.8	17.5	7.3	31.7	14.5
18696	Subsoil	8.3	24.8	11.5	20.9	7.0	17.4	10.4

POPLAR FINE SANDY LOAM.

The Poplar fine sandy loam consists of from 24 to 48 inches of a light-brown or buff-colored, micaceous fine sandy loam, underlain to a depth of 6 feet or more by a reddish or yellowish-brown heavy loam or light clay loam. The surface soil is light, friable, and easily cultivated, while the subsoil is heavy, sticky, and contains but very little mica. In a few cases a hardpan similar to that underlying the San Joaquin soils is found within 6 feet of the surface.

This soil is found in the vicinity of the Tule River, and generally occurs in small, irregular-shaped areas. The largest body lies northwest of Portersville, and covers an area of a little over 3 square miles. The surface features are nearly level, although local areas are so irregular as to necessitate leveling before irrigation can be practiced. Upon the nonirrigated parts of the type the natural drainage is sufficient to take care of the usual slight rainfall, but in irrigated areas considerable difficulty is experienced with waterlogging if great care is not taken in applying the exact quantity of water required. The surface soil is alluvial in formation, the material having been transported long distances, coming originally from the granite rocks of the Sierra Nevada Range. The subsoil is largely reworked Pleistocene material mixed more or less with more recent alluvial material. The type is practically free from alkali. The native vegetation consists of a scattering growth of valley oak and cottonwood and a good growth of grass.

A considerable part of this type is uncultivated, being used for pasturing dairy and range cattle. The cultivated area is planted chiefly to alfalfa, small fruits, and deciduous tree fruits, and to some extent is used for trucking by Chinamen.

Of the alluvial types this soil should become one of the most valuable in the area on account of the heavy subsoil, which holds water well and favors economical irrigation.

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The following table gives the average results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Poplar fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18707, 18709	Soil	0.6	4.4	3.6	24.7	19.2	38.6	8.7
18708, 18710	Subsoil	2.3	9.7	7.1	19.7	14.1	33.1	13.8

PORTERSVILLE COARSE SANDY LOAM.

The Portersville coarse sandy loam consists of from 12 to 72 inches of a black, micaceous, rather coarse sandy loam, underlain by granite rock. The soil contains varying quantities of silt, and the lower-lying areas have a heavier texture.

This type is confined largely to Frazier Valley and to an area near Lemoncove. It lies mainly along the lower slopes of the foothills, although one body extends into the small wash depression in the northern part of Frazier Valley. It is well drained, except on the lower slopes, where seepage water accumulates. It is a residual soil derived from the underlying granite, but has been more or less modified by alluvial agencies and wash.

A lighter-textured phase of the type lies along the higher lands south of Lemoncove, and smaller areas occur near Naranjo and in the northeastern part of Frazier Valley. This phase consists of from 24 to 72 inches of brown or sometimes grayish sandy loam, underlain by masses of granitic rock. The soil contains varying quantities of sharp, angular fine gravel or coarse sand, and bowlders and rock outcrops are of common occurrence.

Not much of this type of soil is under cultivation, though it is sometimes devoted to the dry farming of grain. If irrigation water were available it would prove well adapted to citrus and probably to deciduous fruits.

The following table gives the average results of mechanical analyses of the soil of this type:

Mechanical analysis of Portersville coarse sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18694, 18721	Soil	6.4	20.0	10.3	21.5	9.4	22.3	9.9

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PORTERSVILLE LOAM.

The Portersville loam consists of 18 to 72 inches of grayish-red loam, carrying some mica and underlain by granite bed rock. The upper part of the soil contains varying quantities of waterworn bowlders and gravel, while in the lower part there usually occur appreciable quantities of coarse angular sand or fine gravel, which represents partially decomposed granite.

This soil is confined largely to the granite foothills skirting Frazier Valley, Pleasant Valley, and the valley along the South Tule River. In the upper Pleasant Valley a considerable body of the type juts out from the hills and forms a mesa about 3 miles long along the Tule River. In Pleasant Valley the surface is very uniform, while in the Frazier and South Tule valleys it is rolling and sometimes marked by rock outcrop.

The type is residual in origin, being derived from the underlying granite. It has, however, been more or less modified in places by rain wash and alluvial action. The type is free from alkali. In the lower locations the natural vegetation consisted of a few scattering valley oaks, while in higher and drier locations there were no trees. Aside from a small section in upper Pleasant Valley and along South Tule River devoted to the culture of citrus fruits, this soil is given over to dry farming of grain or to pasture.

The following table gives the results of a mechanical analysis of the soil of this type:

Mechanical analysis of Portersville loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18722	Soil	4.0	11.2	9.0	23.9	8.6	22.5	20.8

HANFORD LOAM.

The Hanford loam consists of from 28 to 60 inches of a very dark-gray or black micaceous loam which is underlain by a heavy yellowish or reddish-brown loam or light clay loam. The texture of this type is quite uniform, except in the vicinity of the San Joaquin types, where the texture of the surface soil approaches a clay loam.

Only two bodies of this soil occur in the area. These are situated 6 miles southwest of Lindsay, along the western edge of the survey. The surface is level and the area has no local drainage channel. On account of the light rainfall, however, it does not suffer from an excess of ground water.

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The surface soil of this type is alluvial material and was deposited in quiet water, while the subsoil is composed of material similar to that forming the San Joaquin series, although it has been somewhat modified by alluvial agencies. The soil is largely devoted to grazing, but some of it is under irrigation and sown to alfalfa, which gives a yield of from 3½ to 6 tons per acre. This soil has proved valuable in the production of this crop. Owing to the heavy subsoil, which has the capacity to retain moisture, it would seem to be a suitable soil for grapes and small fruits.

The following table gives the results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Hanford loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Veryfine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18705	Soil	1.7	6.1	6.7	17.4	9.6	39.8	18.8
18706	Subsoil	.9	6.4	6.7	19.1	13.6	33.5	19.4

LEWIS CLAY LOAM.

The Lewis clay loam consists of 6 feet or more of a heavy grayish clay loam. The subsoil sometimes shows strata of gravel or fine sand, and in a few places a soft hardpan about 3 inches in thickness was encountered. These variations do not occur with sufficient frequency to be considered a characteristic of the type.

This type occupies a long, narrow area stretching across the lower part of T. 19 S., Rs., 26 and 27 E., and extending into the northern portion of T. 20 S., R. 26 E. The surface of this type is uneven and is very similar to the hog-wallow phase of the San Joaquin series. An ill-defined wash extends across a portion of this type, indicating a former course of Lewis Creek. It receives the flood waters from Lewis Creek during the wet season, and on account of the impervious nature of the subsoil, water often stands in the depressions for long periods of time. The type is alluvial in origin and represents fine sediments carried by Lewis Creek and deposited in a body of quiet water.

Alkali is always present and averages from 0.40 to 0.60 per cent for the upper 6 feet of soil. The salts are rather uniformly distributed, though the second foot usually carries somewhat more than the rest of the profile. Except for grazing, the type is of no agricultural importance on account of the alkali and poor drainage, and none of it is under cultivation. Reclamation would prove difficult, owing to the lack of natural drainage, and the probable returns might never justify the expense.

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The following table gives the results of a mechanical analysis of the soil of this type:

Mechanical analysis of Lewis clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18704	Soil	0.7	2.3	1.9	8.3	14.4	49.8	22.3

SAN JOAQUIN SANDY LOAM.

The San Joaquin sandy loam consists of from 1 foot to 6 feet of coarse sandy loam varying in color from a deep red to a grayish red. This is underlain by a dense, impenetrable red hardpan which varies in thickness from 3 or 4 inches to as many feet. This hardpan occurs at varying depths beneath the surface, the average being about 2½ feet. The material beneath the hardpan is a sandy loam very similar in texture to the surface soil.

In general there is little variation in the texture of this soil, except along the lines of contact with the heavier soils of the same series. In the vicinity of Lindsay there is a considerable area, however, which has been more or less modified by earlier washes from Lewis Creek. The texture of the soil here is somewhat lighter and it is more friable and contains some mica. The color is a brownish red. The red hardpan is found everywhere beneath this area, although at a somewhat greater depth than usual.

The surface soil of the San Joaquin sandy loam is sticky when wet and where not cultivated becomes hard and compact, but under careful cultivation it is friable and easily worked.

This soil is the most extensive of any in the area, and were it not for the intervening alluvial fans it would form a continuous body through the entire length of the area. The surface ranges from level to uneven, the latter condition the result of hog-wallow depressions and numerous small low mounds, the elevation of which varies from 1 to 4 feet. This hog-wallow surface is best developed near Lincove, where the distance between the mounds is seldom more than 15 feet and the height of the mounds as much as 3 or 4 feet.

The San Joaquin sandy loam is practically without any local drainage. Along the line of contact with alluvial soils, however, short washes serve to drain small areas during the wet season, and north of Exeter Yokohl Creek and a wash afford some drainage. Over the greater part of the type, however, the rainfall is removed mainly by surface evaporation. When wet the soil has a peculiar boggy property and when a certain moisture content is reached the

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soil loses all cohesion and resembles quicksand. In well-packed roads, however, the soil generally remains firm throughout the rainy season.

The type is lacustrine in origin and is of Pleistocene age. Since deposition in the ancient lake it has been somewhat modified in places by alluvial agencies. In some cases the original soil has been removed by streams and a distinctly alluvial soil laid down over the hardpan. In other cases the modification is the result of a simple reworking of the material with the addition of some stream sediments.

Along the contact of this soil with the alluvial soils there is sometimes found a narrow belt in which the surface soil contains a little alkali, but the quantity is never sufficient to cause any concern. Aside from these limited areas the type is free from alkali.

In general the type is treeless, but occasionally where the hardpan lies at considerable depth below the surface a scattering growth of valley oak is found. It supports a good spring growth of grass and wild oats.

At the present time the larger proportion of the type is dry-farmed to grain. A few small fields of alfalfa were seen and seemed to be making a fair growth where sufficient water had been supplied. The type is being rapidly planted to grapes and citrus fruits; and the latter will do well wherever the climatic conditions are favorable, provided the hardpan, if lying near the surface, be broken up. The soil is well adapted to the production of Tokay, Emperor, and seedless grapes.

Water is available for the irrigation of this soil by pumping from an underground source, the level of which ranges from 25 to 50 feet below the surface. The returns received from fruit grown on this type justify the expense of irrigating by pumping. With the expansion of the area devoted to the growth of citrus and other fruits this soil will play a prominent part in the future agriculture of this section.

The following table gives the results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of San Joaquin sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18718	Soil	8.4	20.7	9.1	16.3	10.0	28.4	7.0
18719	Subsoil	10.6	21.3	8.1	15.2	13.1	22.9	8.6

SAN JOAQUIN LOAM.

The San Joaquin loam consists of from 1 to 6 feet of a heavy red loam, which is very uniform down to within 2 or 3 inches of the hard-

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pan, where it becomes more sandy. The hardpan varies in thickness from 2 to 18 inches, the average thickness being about 7 inches. This is underlain by a lighter soil material closely resembling that found below the hardpan of the San Joaquin sandy loam. The line of demarcation between this soil and the latter type is usually indistinct as they merge gradually into each other. Between this soil and the San Joaquin clay adobe, however, the boundary is definite.

This type is very sticky when wet and becomes hard and compact when dry. The surface is broken by numerous small mounds and hog wallows and leveling is necessary before irrigation can be practiced.

The San Joaquin loam, although rather widely distributed, does not occur in large areas. The largest area lies east of the line of the railroad from Strathmore Station toward the foothills, near Orangehurst, southwest of Lindsay and near Portersville. Along a line of contact with this soil and the alluvial soils of the Kaweah River there is a drop of from 2 to 10 feet.

Practically no drainage ways traverse this soil, but as in case of the San Joaquin sandy loam small areas of it are drained by a few short draws extending from the river bottoms.

The type is lacustrine in origin, having been deposited in Pleistocene time, but it has been more or less altered by subsequent erosive agencies. Although scattered trees of valley and blue oak occur near the alluvial soils, or where the hardpan is at a considerable depth, the San Joaquin loam is generally treeless. Native grasses and wild oats flourish and are cut for hay or grazed. The greater portion of the type is devoted to dry farming or used as pasture. Adjoining the adobe soils along the foothills an increasing acreage is being planted to citrus fruits with good results. For the successful growing of these trees it is necessary to break up the hardpan by blasting. It is believed that grapes and small fruits would do well.

The following table gives the results of a mechanical analysis of the soil of this type:

Mechanical analysis of San Joaquin loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18716	Soil	1.8	7.5	5.0	13.0	10.5	38.0	23.8

SAN JOAQUIN CLAY ADOBE.

The San Joaquin clay adobe consists of from 1½ to 6 feet of clay, with the characteristic adobe property of checking upon the surface when dry. The color of this soil is dark red—somewhat darker than the other soils of this series. It is underlain by a dense red

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hardpan, which varies considerably in thickness, but has an average thickness of about 7 inches. This soil is confined to two small areas about 4 miles southwest of Lindsay, a small area near Exeter, and one near Strathmore. It is the least extensive of the San Joaquin soils. It is without any local drainage whatever, and the hog-wallow depressions hold water long after the surface of the surrounding country has become dry.

This type is also lacustrine in origin and of Pleistocene age. It is devoted entirely to grazing or to dry farming.

The following table gives the results of a mechanical analysis of the soil of this type:

Mechanical analysis of San Joaquin clay adobe.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18720	Soil	0.5	2.4	1.8	10.4	11.1	32.0	41.4

PORTERSVILLE CLAY LOAM ADOBE.

The Portersville clay loam adobe consists of from 2 to 6 feet of a heavy dark-brown clay loam carrying quantities of subangular rock fragments varying in size from small stones to pieces several inches in diameter. Northeast of Redbank, along the eastern slope of Badger Hill and on the slopes south of Deer Creek, there are small areas where the rock fragments in the soil are so numerous as to make the type approach a stony loam adobe, otherwise the texture of the surface soil is remarkably uniform throughout the entire area. The presence of the rock fragments sometimes interferes to some extent with cultivation. When dry and hard it is practically impossible to cultivate the soil, and after rains or irrigation it can not be cultivated for a week or so on account of its sticky nature.

The subsoil is a somewhat lighter textured material and varies in color from a reddish brown to almost white. It usually carries considerable lime and is locally spoken of as "marly." The subsoil is more compact than the soil, and occasionally at depths varying from 3 to 5 feet a still more compact layer closely resembling a hardpan is found. In such areas the percentage of lime is considerably above the average and the compact stratum is probably due to the cementing action of this salt. In uncultivated areas underlain by this stratum the surface checks upon drying, and where the checking is extreme it is locally known as "dry bog" adobe.

This type is found bordering the outer slopes of the foothills from the southern boundary of the area nearly to Lemoncove, unbroken

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except for narrow strips where stream courses issue from the hills. North of Lemoncove the type is broken at intervals by other soils. A few small areas occur along the foothill slopes in the Frazier and Pleasant valleys. In general, the type is confined to the lower slopes of the foothills, but near Plano, south of Deer Creek, and east of Strathmore, it projects out into the valley on ridges somewhat higher than the surrounding country. Along the foothills the surface slope of this soil is quite steep, gradually becoming less as it nears the valley soils. The uniform slope of the surface occasionally is broken by narrow washes formed by drainage water from the higher slopes during the wet season. Between Deer Creek and Plano it occupies two ridges, which project out into the valley and stand considerably higher than the adjacent soils, while east of Strathmore it is but little above the surrounding country. Owing to the heavy nature of the soil and the steep surface slope the surface drainage of the type is good, but it has a tendency to crack, which favors the absorption of water during the early part of the rainy season. The subsoil is exceedingly compact and holds the moisture well.

The Portersville clay loam adobe is a residual soil derived from the weathering and decomposition of the underlying metamorphic and granitic rocks. Associated with these rocks is magnesite and lime, the decomposition of which probably accounts for the marly characteristic of the subsoil. Where the metamorphic rocks border higher lying masses of granitic rocks the soil from the latter sometimes washes down and imparts a sandier texture to the type, while along the lower slopes the texture is usually heavier, due to the gradual downward movement of the finer soil particles.

This soil is free from alkali. The subsoil, however, is occasionally highly calcareous in small areas, and in such places the growth of citrus trees is affected to a greater or less extent. This type was originally devoid of any forest growth, but it supports a good growth of native grasses. It is one of the most valuable types in the area because of its special adaptation to the orange and lemon. It was formerly devoted to the production of grain, but practically all of it is now planted in citrus groves.

The following table gives the results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Portersville clay loam adobe.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18711	Soil	4.3	8.4	4.1	7.8	6.8	32.3	36.1
18712	Subsoil	3.1	6.9	3.8	7.9	9.6	32.1	36.2
18713	Lower subsoil	10.4	17.2	7.7	12.8	9.5	17.7	24.6

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PORTERSVILLE CLAY ADOBE.

The Portersville clay adobe consists of a heavy black clay adobe 6 feet or more in depth. Occasionally a few small rock fragments are present and in the western portion of Frazier Valley, north of Stony Hill, a large quantity of small, white, subangular lime concretions give the soil a grayish instead of the usual black color.

A very characteristic feature of this type is the checking of the surface upon drying. The soil cracks into very small fragments, and from this action it has been given the local name of "dry bog." This checking is so fine that in walking over dry, uncultivated ground a person will sink into the soil up to the ankles. When wet this soil is exceedingly tough and waxy.

The Portersville clay adobe usually occurs at lower elevations than the Portersville clay loam adobe. In the Frazier and Pleasant valleys, where the largest areas of this soil occur, it is found both on the foothill slopes and in the lower portions of the valleys. In those locations where the surface is level or nearly flat the drainage is rather poor, while upon the foothill slopes the drainage is much better. The soil is so impervious that there is but little lateral movement of water through it and when once thoroughly saturated it dries out very slowly.

In origin the Portersville clay adobe is largely colluvial. It represents a wash of the finer soil particles from the Portersville clay loam adobe which occupies the higher slopes adjoining. Its dark color is due largely to the high percentage of organic matter derived from heavy growths of vegetation which flourish under the moist conditions. Some alkali is present in the lower depths of the soil, but the amount is usually so small that it will never cause trouble.

A heavy growth of grass is found on the poorly drained area and a fair growth on the higher portions. The land is used at times for dry-farming grain, with only fair results, as the checking of the surface injures the roots and allows the surface soil to dry out and kill the plants. Where water is obtainable it is believed that citrus fruits can be produced.

The following table gives the results of a mechanical analysis of the soil of this type:

Mechanical analysis of Portersville clay adobe.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18714	Soil	1.3	5.0	3.2	5.7	6.7	34.4	43.5

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ROUGH STONY LAND.

Rough stony land consists of areas having a rolling or precipitous surface or containing such large quantities of angular or waterworn bowlders or masses of rock outcrop as to be of little use for agriculture. Areas of this character are found in the extreme eastern part of the survey, mainly south of the Tule River. Along the draws and water courses there is a scattering growth of oak. The land is of no use except for grazing.

RIVERWASH.

Riverwash consists of a mixture of sand, gravel, and bowlders, and occurs in narrow bodies along the immediate courses of the St. Johns, Kaweah, and Tule rivers, and along Deer Creek. The surface is rough and gullied and is subject to overflow during high-water stages of the streams. The drainage is poor, the water table seldom lying more than 5 feet below the surface. This type has been formed by the mass of coarse material brought down by the stream and deposited along its course during times of high water. It is usually covered by a growth of water-loving trees, and by a scant undergrowth of grass and weeds. It is of no agricultural value, being subject to overflows, and large stones and bowlders preventing cultivation. It is used to a limited extent for pasture and also affords a supply of firewood for local use.

IRRIGATION.

Irrigation in the Portersville area is accomplished both by systems of gravity canals and by means of pumping plants which draw their water from underground sources.

Canals take water from the Kaweah, Tule, and South Tule rivers and from Lewis and Deer creeks. The Kaweah and Tule rivers supply the larger part of the water for the area. The former has its source far back in the forest-clad Sierras, where a constant flow is maintained by the rains and melting snows. The highest stage of these streams occurs from March to June, after which the water slowly falls until a minimum flow is reached in October and November.

The annual discharge of the Kaweah River[a] in acre-feet is subject to a wide fluctuation, the minimum, in 1879, being about a quarter of a million acre-feet, while the maximum, in 1884, was about five times as much. The annual discharge of the Tule River[a] in acre-

[a] Water-Supply and Irrigation Papers Nos. 81, 100, 134, 177, 213, U. S. Geological Survey.

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feet is considerably less than that of the Kaweah. It is likewise subject to wide fluctuation from year to year, the minimum, in 1901, being 53,330 acre-feet, while the maximum, in 1880, was 396,027 acre-feet. Lewis and Deer creeks are small streams, having their sources in the lower mountains, and hence carry water into the valley for but a short time during the wet season. The irrigation water from both surface and underground sources is of good quality, and no injury has ever resulted from alkali or other impurities. A large percentage of the annual flow of the streams goes to waste each year during the wet or flood season.

Canals taking water from the Kaweah River are Wachumna Ditch, Tulare Ditch, Kaweah Irrigation and Power Ditch (Pogue's Lower Ditch), and the Lemoncove or Pogue's Upper Ditch.

The Wachumna Ditch takes water from the river between Lemoncove and Naranjo. The main canal flows westerly for about 4 miles into an artificial reservoir (Bravo Lake), which is used for the storage of water during the high stage of the river. This canal irrigates a small acreage in the northern tier of sections in T. 18 S., R. 26 E. The larger part of the water is used for the irrigation of land lying outside the limits of the present survey. A small lateral runs along the foothills near Naranjo and irrigates some citrus orchards in that section.

The Kaweah Irrigation and Power Canal takes water from the river on the south side east of the limits of the area and flows along the hillside west of Lemoncove and south to a point about 4 miles northeast of Lindsay. The water is used largely upon lands east and southeast of Exeter.

The Lemoncove Ditch has its source a short distance above the Kaweah Irrigation and Power Canal and covers a small acreage of citrus lands in the vicinity of Lemoncove. The surface of the land here is rolling and the higher lands are irrigated by pumping from the canal.

Along the Tule River there are about a dozen canals which draw water from the Tule River and irrigate lands in the present survey. In the eastern part of the area Pleasant Valley and Graham canals furnish water for lands lying north and south of the river. The earliest appropriation of water from this stream, however, dates back to 1860, when water was taken out on the north side about 8 miles east of Portersville and brought to a point near the eastern limits of that town to furnish power for a grain mill. In 1867 the owners incorporated as the Tule River Pioneer Water Ditch Company. Later the company was reorganized, the canal, enlarged and extended, now being known as the Pioneer Ditch.

During the low stages of the river pumping from an underground source is necessary in order to furnish sufficient water for the lands

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under the canal. This canal irrigates about 12,000 acres of land north and northwest of Portersville suitable for the production of citrus and deciduous fruits, as well as for general farming.

About 4 miles east of Portersville an old channel of the Tule River leaves the present course of the stream and flows across the alluvial bottom lands in a northwesterly direction. At its junction with the river a low diversion wier has been installed, which diverts a part of the flow from the main river. This water is used by several small canals west of Portersville. They are entitled to water only during high stages of the river, and carry water during the late winter and spring months.

On the south side of the river the Poplar Ditch is the largest canal. The water is diverted from the river near the wagon bridge south of Portersville, the canal running in a westerly direction along the southern boundary of the alluvial soils and irrigating a considerable acreage in the vicinity of Poplar.

Several small canals take water from the river on the south side during the high stages of the stream. These cover small areas of alluvial soil in the western part of the survey. A canal on the south side of Deer Creek carries water to land in the southwestern part of the area whenever the water of the creek flows as far down as the headgates of the canal, which is only for a short time in the spring.

The cost of water per acre for irrigation under the gravity canals ranges from $1 to about $6 a year.

The pumping plants are sometimes owned and operated by companies, as is usually the case with the gravity canals, but most of the pumping plants are private, and it is only where the lift is very high and the first cost of installation great that a company is organized. The cost of putting in a pumping system varies according to the depth of the water table and the elevation of the land to be irrigated. Generally the cost ranges from $25 to $45 an acre. The cost of irrigation after the plant is in working order also differs in each case. It is greatest upon the hillside lands and least upon the level lands in the valley where the water table is closer to the surface. Generally the expense ranges from $5 to $25 an acre per year.

When the further extension of the citrus orchards under the gravity canals became impossible, owing to the limited supply of water in the streams, the growers turned their attention to the underground supply. Considerable difficulty is experienced in getting water at reasonable depths within 1 mile of the hills, except near the larger streams. Farther into the valley a good supply of water is obtainable at depths ranging from 25 to 150 feet. Many wells have been sunk in recent years and the development of the underground supply has made possible a great increase in the acreage of citrus groves.

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Electric motors and gasoline engines are used to operate the pumping plants. The electricity is furnished by two companies, one having extensive water-power electric plants in the Sierra Nevada Mountains northeast of the area, and the other a plant located in the northern part of the area. Power is sold by the companies at the yearly rate of $50 per horsepower.

The area now irrigated by gravity canals has practically reached its limits under the present conditions, but by storing the surplus flood water in the mountains it is believed that a much greater area can be irrigated under this system. The underground water supply is also capable of a much greater development than at present.

In the districts devoted to the growth of fruits, water is applied by the furrow method, while alfalfa is irrigated by the check system. Grain is seldom irrigated, but when it is, flooding is resorted to. Under the canal system, irrigation usually begins soon after the rainy season closes, which may be from March 1 to the middle of April. At this time the soil is still moist, but as many of the canals get water from the river only for a short time, the farmers put on all the water possible while it is available. On lands under the older canals irrigation rarely begins before the 1st of May, as water is available throughout the summer.

SUMMARY.

The Portersville area is located in the central portion of Tulare County, along the lower edge of the foothills of the Sierra Nevada Mountains, and covers about 300 square miles of cultivable land.

Portersville, Exeter, and Lindsay are the principal towns. The area is crossed by a branch of the Southern Pacific Railroad, which gives communication with outside markets.

The climate is arid, and is characterized by long, hot, dry summers, a mild winter rainy season, little wind, and a large number of sunshiny days. Heavy frosts are almost unknown. The annual rainfall, averaging about 8½ inches, occurs largely between December and April.

Production of citrus fruits is now the leading industry. From a beginning in 1882 the acreage in groves has increased to nearly 14,000 acres and the output to an average of about 2,500 carloads, chiefly oranges. The Washington Navel orange has the largest acreage, followed by the Valencia Late, lemons, and seedling oranges. The principal citrus soils are the Portersville clay loam adobe and the San Joaquin sandy loam and the San Joaquin loam. Average net returns from citrus groves range from $250 to $350 a year. Land suitable for orange culture sells for $50 to $175 an acre, depending upon the location and the supply of water.

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Deciduous fruits are proving a success on the alluvial soils and San Joaquin soils, and the acreage is increasing rapidly. Grapes are profitably grown on the same soils.

Alfalfa gives good results on the alluvial soils, and is the important forage crop in dairying.

Grain is grown in the nonirrigated sections of the area, particularly on the soils of the San Joaquin series, the yield ranging from 2 to 15 sacks per acre.

In the past large individual holdings of land have been the rule, but now most of these large tracts are being cut up and placed on the market in 10, 20, 40, and 80 acre lots.

Irrigation is practiced throughout the area, except where the land is dry farmed to grain. Irrigation water is secured from the streams and from an underground supply. The cost of irrigation varies from $1 to $30 per acre a year.

Although the entire belt of alluvial soils generally shows traces of alkali on the surface, there are no harmful amounts in the soil except in two small areas, one north of Lindsay and one west of Portersville.

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SOIL SURVEY OF THE PAJARO VALLEY, CALIFORNIA.

By W. W. MACKIE.

DESCRIPTION OF THE AREA.

The Pajaro Valley, comprising about 120 square miles, forms a round, basin like inclosure about 10 miles long and 8 miles wide. It is about 100 miles south of San Francisco, close to latitude 37° north and longitude 121° west. The valley is almost entirely inclosed by mountains and hills. On its eastern side the Santa Cruz Mountains pass in a northwesterly direction. From the extreme southeast corner a spur from this range, known as the Monterey Hills, extends directly westward to Monterey Bay. Another spur from the Santa Cruz Mountains passes southward from the northwest corner of the area, almost joining the Monterey Hills, but being separated by the Pajaro River, which flows into the ocean at this point, having broken through the Santa Cruz Mountains at Chittenden, in the southwestern corner. Across the mouth of the Pajaro River there is a wind-blown bar of Dunesand about 30 feet in height and 1 mile in length. These natural barriers thus entirely inclose the valley, affording shelter and protection.

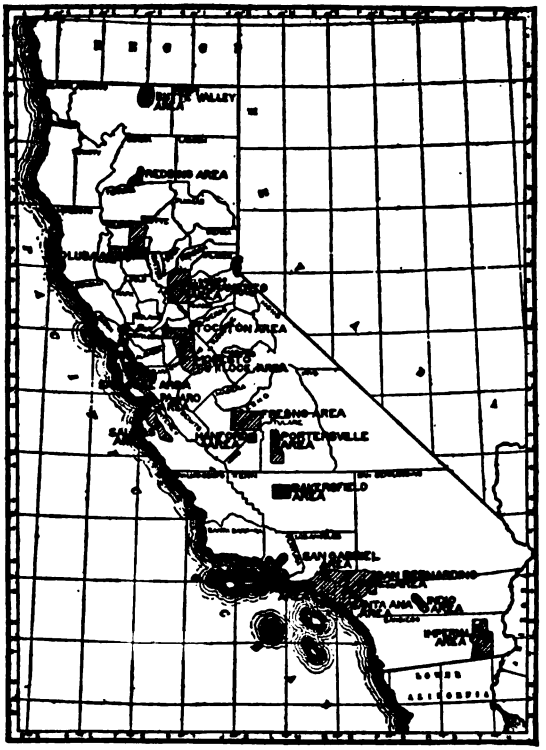

FIG. 37.—Sketch map showing location of the Pajaro Valley area, California.

Entering the valley from the west through the narrow defiles at Chittenden, the Pajaro River divides the valley into two unequal

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parts, one-third lying to the south in Monterey County and the other two-thirds to the north in Santa Cruz County. On the Monterey side no tributary stream enters the valley, but on the Santa Cruz side several creeks rising in the Santa Cruz Mountains flow through the valley southward into the Pajaro River. These streams give rise to valleys which are named after them; thus the Pajaro, Green, Brown, Corralitos, and Larkin valleys. These little valleys are separated by low, rolling hills which are usually tilled. Several small picturesque lakes, which add to the supply of irrigation water, occupy some of the depressions, the largest being College Lake, 2 miles northeast of Watsonville.

On account of its inclosed position the Pajaro Valley escaped the notice of Cabrillo and Drake, the early Spanish and English explorers. It was not discovered until 1769, when Don Gaspar Portola headed an overland exploring expedition consisting of 40 soldiers and 15 Indians. On entering the valley they found it full of game, especially wild fowl, hence the name El Pajaro, a bird. It was here, near its southernmost limit, that the redwood (*Sequoia sempervirens*) was first discovered growing abundantly over much of the valley north of the Pajaro River. Later the Santa Cruz mission used this valley as a pasture for their herds, but it was not until 1820 that the first land grant was requested from the King of Spain by Don Antonio Maria Castro, known as the Rancho Vega del Rio Pajaro, consisting of 4,300 acres between the towns of Aramos and Vega. At this time (1820) Mexico gained her independence, so the subsequent grants were all Mexican. The early established ranchos were devoted almost exclusively to grazing, with occasionally a small field of Indian corn or a garden.

In 1846 California was ceded to the United States, which recognized all Mexican land grants made previous to this time. The indefiniteness of these grant lines led many unscrupulous Americans to take advantage of the native Californians, depriving most of them of their lands. These practices and new conditions soon placed the ranchos in American hands. Soon after this Watsonville was founded. In 1870 the Southern Pacific Railway entered the valley from San Francisco. From this time on there has been a steady increase in population, until at present the Pajaro Valley contains about 15,000 inhabitants. Railroad facilities have been added, placing the valley on the main transcontinental line as well as connecting several local branches running to Santa Cruz and elsewhere. A narrow-gauge railroad connecting Watsonville and Salinas acts as a feeder for the immense beet-sugar factory at the latter place, besides affording ocean transportation by its connection at the port at Mass Landing. An electric railroad also connects Watsonville with Port Watsonville on the bay. Another railroad is almost completed into

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the valley from Hollister, in San Benito County. Elkhorn Slough, which extends inland from Monterey Bay to Hudson Landing, 4 miles from Watsonville, now carries considerable freight, which could be greatly increased by properly dredging this channel for coast-trade vessels.

The county roads in the valley, on account of the varied topography and irregular property lines due to the old Mexican grants, follow natural rather than artificial lines. One main highway enters the valley along the Pajaro River from the Santa Clara Valley, and parting at Chittenden passes along both sides of the river, connecting with Monterey to the south and Santa Cruz to the north. These and many other roads of the valley are macadamized or gravel ballasted and well sprinkled during the dry summer months, making them ideal for either teaming or automobiling.

Watsonville, containing 5,500 inhabitants, is the principal town of the valley and lies nearly in the center on the Southern Pacific Railway.

CLIMATE.

The climate of the Pajaro Valley, like that of California generally, is characterized by two seasons—the dry or summer season extending from May to October, inclusive, and the wet or winter season comprising the remaining months. Rains sometimes fall in May and October, but there is practically none during the remainder of the summer season. During the rainy or winter season the prevailing winds are either from the north or south, causing alternate rainy or clear weather, but during the summer they are all from the west or northwest from off the Pacific Ocean. These winds, owing to their great regularity, are called the "trade winds." They usually spring up each morning between 10 and 12 o'clock, continuing with increasing vigor until sunset, when they again subside. Just off the coast of California and along its entire length these trade winds blow directly across the cold waters of the Japanese current in its course southward from Alaska. When the warm trade winds come in contact with these cold waters great condensation of atmospheric vapor at once ensues, creating dense fogs which obscure the sun. Usually about 10 o'clock in the forenoon, when the wind begins to blow, these fogs are dispelled for the remainder of the day.

The presence of these cool fogs is turned to profitable account because the high humidity not only keeps down soil evaporation, but it likewise keeps apples and berries turgid and crisp, wholly eliminating danger of sunburn. Such conditions tend to obviate the necessity for irrigation for ordinary crops.

Rains occur at intervals during the winter, but at this season fogs are almost entirely lacking. For many weeks at a time the daily

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variation between maximum and minimum temperatures does not exceed 6° or 8° F. The average means for summer and winter show a difference of but 7° F., the mean annual temperature being 60° F. The annual rainfall varies from 20 to 45 inches, the average being about 24 inches. The following tables compiled from the records of the Weather Bureau station at Watsonville show the monthly and annual temperature and precipitation, and also the maximum and minimum temperature for certain years:

Normal monthly and annual temperature and precipitation at Watsonville.

Month.	Temperature.	Precipitation.	Month.	Temperature.	Precipitation.
	° F.	Inches.		° F.	Inches.
January	52.4	4.45	August	62.8	0.00
February	52.3	3.40	September	60.3	.16
March	55.1	3.62	October	58.4	1.76
April	56.6	1.69	November	56.1	3.82
May	58.7	.66	December	51.3	4.09
June	62.4	.17			
July	63.3	.00	Year	57.5	23.82

Monthly and annual temperature and precipitation at Watsonville.

Month.	1904.		1905.		1906.	
	Temperature.	Precipitation.	Temperature.	Precipitation.	Temperature.	Precipitation.
	° F.	Inches.	° F.	Inches.	° F.	Inches.
January	52.0	1.63	51.9	3.64	52.0	5.90
February	54.0	4.14	53.0	4.46	55.6	4.93
March	55.6	6.68	56.2	4.26	55.0	5.88
April	60.3	1.89	57.2	1.30	60.2	.86
May	67.0	.00	60.0	4.27	63.1	2.43
June	67.0	.00	61.0	.00	69.7	.24
July	67.0	.00	63.4	.00	67.8	.00
August	67.9	.13	65.6	.00	64.3	.00
September	69.9	2.36	62.4	.00	65.2	.00
October	63.0	1.89	56.9	.00	62.5	.00
November	57.2	.82	53.5	1.59	55.0	.82
December	51.8	1.56	50.6	1.75	52.8	12.55
Year	61.0	21.10	57.6	21.27	60.3	33.61

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Maximum and minimum temperature for Watsonville.

Month.	1905-6.		1906-7.	
	Maximum.	Minimum.	Maximum.	Minimum.
	° F.	° F.	° F.	° F.
July	79	59	76	57
August	76	57	71	57
September	74	54	76	56
October	72	52	75	51
November	66	49	67	47
December	62	44	60	45
January	61	47	65	30
February	64	52	78	35
March	63	50	71	36
April	69	54	78	48
May	67	54	80	51
June	74	57	86	52

AGRICULTURE.

The agriculture began in the Pajaro Valley in 1823, when the Spanish dons applied for their first land grants from Mexico. These grants or ranchos were at first devoted entirely to the raising of herds of cattle and horses. The only land cultivated was the small garden or patch of Indian corn for family use. The first iron plow was used in 1851 by J. B. Hill, an American, who leased 1,000 acres of the Salsipuedes Rancho. He at once planted 200 acres of potatoes, which produced an immense yield, selling for 15 cents per pound. These handsome profits soon caused all of the alluvial bottoms, or Pajaro soils, to be cultivated to potatoes and wheat. A yield of 130 bushels of wheat per acre is recorded for these soils.

Grain farming later gave way to the culture of apples and sugar beets, and grain is now produced on the Watsonville soils north of the river and on the low rolling hills of the valley, on the Monterey sandy loam north of the river, on the Santa Cruz sand near the coast, and on the heavy black soils of the Pajaro series. No wheat is produced, but barley is grown on the heavy bottom soils, oats on the sandy coast soils, and both on the Watsonville soils.

Of the 10,000 acres or more in grain, half is cut for grain hay and the remainder thrashed for grain for stock-feed and brewing purposes. It is all fall or winter sown, the barley on summer fallowed land. Good crops are secured. Barley often produces 30 sacks (of 100 pounds) per acre on heavy black soils, and oats as much as 60 bushels per acre. Barley is the preferred grain crop used in rotation with potatoes or sugar beets.

Alfalfa is grown on all the alluvial or Pajaro soils, producing four cuttings or 6 tons of hay annually per acre, which sells for $10 to $14

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a ton in the local market. There is a good demand for alfalfa hay and pasture, but the open land for alfalfa is very scarce and too high priced for this crop and the summer climate is too cool for the best returns. Irrigation, while not necessary, considerably increases the yield. Poor drainage is very detrimental to the growth and success of this crop and if grown on the heavy or adobe soils good drainage is very essential. Australian rye grass grows abundantly in the wet, poorly drained soils where alfalfa would die. It is likewise well adapted to the wet peat soils. It is prized for dairy pasturage and when cut while green and succulent makes excellent hay and later affords considerable pasture. The cool summer climate is well suited to it.

About 3,000 acres are cultivated to potatoes annually, yielding about 150,000 sacks, or 16,000,000 pounds. The potato is grown commercially only on the alluvial or Pajaro series of soils. The lighter soils of this series, including the silt loam, fine sandy loam, and sandy loam, found close to the streams, tend to produce a high-topped, inferior Burbank potato, which is earlier than the low-topped or regular Burbank variety grown exclusively on the darker heavier soils like the Pajaro loam and black adobe, where it yields from 150 to 200 sacks per acre of fine quality.

Potatoes grown on the same soil for more than two years consecutively show a decided decrease in yield. To overcome this the land is rotated with beans and barley or sugar beets. A common rotation is potatoes, barley or sugar beets, and beans, and then potatoes again. Sometimes the bean or legume crop is left out of the rotation, in which case the results are not so satisfactory. Horse beans, vetches, or field peas, sown in the fall and plowed under during the early spring, would save a year in the rotation and add a leguminous crop. This process would keep the land productive for potatoes and sugar beets. It would also renew the best soils, which have been worn out by the growing of potatoes and grain.

The growing of sugar beets began in 1888 when the Watsonville beet-sugar factory was erected. At first sugar beets were found to be more profitable than beans, grain, or potatoes, largely excluding these crops. With the rapid increase of apple orchards, however, the production of sugar beets declined until the crop was reduced to 2,800 acres, producing about 31,000 tons, at which it now remains constant. This reduction caused the removal of the beet-sugar factory to Salinas, 16 miles away, to which place the beets are now sent on a narrow-gauge railroad. Sugar-beet growing is at present confined to the alluvial soils of the Pajaro River lying too near the coast for successful apple culture. It is a profitable industry, insuring to the renter of these lands a fair profit after paying an annual cash rental of $15 to $25 an acre. The average yield is more than

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20 tons per acre. The sugar content of the beets is high, often running up to 20 per cent and maintaining an average of 18 per cent. No irrigation is required and many good yields have been secured in fields planted after the last rain for the season.

Sugar beets can not be grown profitably on the same land for more than two or three seasons without a change of crop. It is better to rotate in the same manner as indicated for potatoes, never planting successive crops of beets. No fertilizer is used, but considerable potash is removed when the beet tops are hauled away to feed cattle. Some farmers feed and milk their dairy cows in the beet fields, and by thus feeding them on the beet tops the potash is returned to the soil as manure.

Beans are grown as a rotation crop and between the rows of young orchards. About 2,000 acres are planted, producing from 1 to 1½ tons per acre. The Lady Washington is used for a short-season crop, but the little white Boston bean is the favorite. Pink and bayou beans are also grown. Beans do well on almost any soil that is well tilled and kept moist. The low alluvial soils are preferred, however, on account of heavier yields.

Onions are planted on about 200 acres yearly, and produce over 5 tons to the acre, selling from $20 to $30 per ton. As the onion requires a great deal of hand labor in cultivation, small fields only are planted. The seed is sown in September in beds and in late November and December the plants are set in the field and cultivated until the harvest in May or June. The heavy alluvial soils of the Pajaro series, especially the loam, silt loam, and adobe, produce fine onions. The Peat also produces good crops.

Dairying is a very profitable industry. In 1906, 250,000 pounds of butter and 460,000 pounds of cheese, besides large quantities of fresh milk, were produced in the area. For this purpose the second-grade hill soils and brush-covered slopes were used, especially those nearer the coast, where native grasses are plentiful.

Poultry raising is exceedingly profitable in this equable climate, which favors the health and growth of fowls. The White Leghorn is the favorite breed. In 1906, 400,000 dozen eggs and many thousand fowls were shipped out of the area.

The eucalyptus, an Australian hardwood tree, finds a congenial climate and soil in the Pajaro region. Like the native redwood it collects and condenses the summer fogs, which fall in showers from its branches and leaves, affording ample summer moisture. In winter the rainfall of 24 inches is more than sufficient for all purposes. In 1868 the first eucalyptus, a manna gum (*E. viminalis*), was planted on the C. H. Rogers place, and is now 6 feet in diameter at 5 feet above the ground and 150 feet or more in height, with a very wide sweep. Blue gums (*E. globulus*) planted twenty-eight years ago in a

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grove on poor, shallow Watsonville loam soil, now average 3 feet in diameter and more than 100 feet in height. While the eucalyptus grows best on deep, rich alluvial soils, those soils are too valuable in other ways for commercial plantings of these trees. The inferior hill or residual soils of the Santa Cruz and Watsonville series, the Monterey sandy loam, and the Encina sandy loam produce trees but little inferior in size to those grown on the better soils. Even on the Pajaro sand near the seacoast young trees have made an average growth of 8 to 10 feet in height per year.

The minimum temperature for this region is 30° F. and is very seldom as low as 30°, while the interior valleys show a minimum from 18° to 20° and San Bernardino Valley a minimum of 23°. Thus the climate of the Pajaro Valley is favorable to the growing of eucalyptus of the more delicate and valuable lumber varieties as well as of the hardy sorts. Among the former may be mentioned the straight-grained sugar gum (*E. corynocalyx*), the straight-growing, pinelike *Eucalyptus resinifera*, and iron-bark (*E. crebra*). The red gum (*E. rostrata*) and *E. tereticornis* would also produce good, large trees. Several of these, especially the blue gum (*E. globulus*), naturally reseed themselves in the Pajaro Valley and could, therefore, be easily grown in local nurseries. Fields unproductive of other crops and brush-covered slopes could be used to advantage in growing these trees. The eucalyptus trees should be planted in the fall about 6 feet apart. The soil should be prepared the same as for grain and the trees cultivated for two years.

THE APPLE INDUSTRY.

The first apple orchard was planted in 1853 as a family orchard on the C. O. Stilliman farm, northeast of Watsonville. The varieties planted were the Smith Cider, Rhode Island Greening, Gravenstein, Jonathan, Yellow Newtown, and Bellflower. The yellow varieties, Yellow Newtown and Yellow Bellflower, soon proved far superior and were almost exclusively planted until at present they constitute more than four-fifths of all the apples planted.

In 1860 not more than 50 acres were in orchards, but this acreage was slowly increased to 250 acres by 1870, when the railroad entered the valley. The rapid planting of apple orchards in the Pajaro Valley was due, however, to the ravages of the codling moth and San Jose scale, which ruined the apple orchards in the Santa Clara Valley in 1874. These pests did not enter the Pajaro Valley until many years later. By 1880 the acreage in apple orchards had increased to 500 acres. The rapid extension of orchards which took place during the next decade was greatly facilitated, if not made possible, by the production of strawberries between the trees, which

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gave very profitable returns for the first five or six years during the time when the orchards were not producing crops. The strawberries were irrigated. By 1890 the acreage in apples had increased to 2,500 acres.

In 1888 a large beet-sugar factory was built in the valley and this gave an added stimulus to orchard planting by providing a paying crop which could be grown between the rows of young trees without the aid of irrigation. This increase in planting continued steadily until the winter of 1901–2, when 1,800 acres, the largest yearly planting, were added, covering practically all the remaining alluvial or bottom soils fitted for apple culture. From 12,150 acres in 1901, the planting has slowly increased to nearly 15,000 in 1907. The later plantings have been made largely in the plains or rolling, hilly residual soils of the valley, included in the Watsonville series. Of this present acreage two-thirds, or 10,000 acres, occupies that portion of the valley in Santa Cruz County and one-third, or 5,000 acres, is found south of the Pajaro River in Monterey County. The orchards at present contain more than 1,000,000 trees, of which one-half are not in bearing, but will be in a few years. As the apple crop now amounts to 3,000 carloads, or 2,000,000 boxes, per annum, a decided increase may be expected, reaching probably 5,000 carloads.

In selecting soils for orchard culture it has been commonly noted that the native vegetation is a good guide. Those soils, whether alluvial or residual, which grew redwoods have proved excellent apple soils. In case of the residual sandy loams, those which produce the larger specimens of live oak are found superior. Treeless sandy soils are too porous to retain sufficient moisture or are underlain at a too shallow depth by a bed rock of sandstone to make good orchard soils. Shale soils having scanty or no tree growth are usually underlain by partially weathered impervious clay shales. Those residual soils rich in lime produce fewer trees and shrubs and are usually covered by a dense growth of grass and weeds, while the residual soils containing little lime produce heavy growths of trees and chaparral. Certain herbaceous plants also aid in selecting soils, among which may be mentioned the horse-tail (Equisetum), which indicates an excellent berry and orchard soil. Sorrel, on the contrary, indicates a poor orchard soil which is usually in need of liming.

The yellow varieties of apples are preferred in the Pajaro Valley, and comprise a large proportion of all the plantings. The Yellow Newtown covers about 50 per cent, and the Yellow Bellflower more than 25 per cent of the acreage. Demand from Australia and elsewhere for red varieties has increased the planting of the Red Winter Pearmain, Smith Cider, and Missouri Pippin. The other popular varieties grown are in the following order: White Pearmain, Lawver, Lankford, Jonathan, and Gravenstein.

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The climate of the Pajaro Valley is generally considered more favorable for yellow varieties of apples than for red ones, the latter in many places having been found not to color well. It has been found that the various soil types show marked differences in their effect on the color of apples. Those soils possessing good textural drainage, or through which water percolates rapidly, give a fruit of higher coloring. Such soils are the sandy loam and fine sandy loam of the Pajaro, or alluvial, series, the sandy loam of the residual series, the Corralitos loam, Salsipuedes loam, and Monterey sandy loam. In the alluvial soils included in the Pajaro series rapid surface drainage is lacking on account of the level topography. Such soils often show a deficiency in the color of fruit, but this can be remedied to some extent by establishing better drainage. When the subsoils become more porous from an increase of sand or gravel this good effect is also noticeable in the fruit. The Pajaro sandy loam and fine sandy loam show an increase or heightening of color in apples over more impervious soils of the same series, like the Pajaro adobe, Pajaro loam, or even the Pajaro silt loam. The Pajaro silt loam gives better color than the loam or adobe on account of the admixture of mica, which improves the textural drainage. Tile drains on the more retentive soils would surely heighten the color of the fruit and hasten its maturity. Early maturity is closely connected with high coloring. Thus apples grown on the protected slopes or sandy types of soil mature earlier than on the heavier soils and the fruit is much higher colored. For this reason the Santa Cruz sandy loam and Santa Cruz loam are the more suitable soils for the red varieties, while the yellow varieties have a brighter, clearer color. The setting of the fruit also bears some relation to the texture of the soil or to the different conditions of climate or drainage connected with the different areas which the soils occupy. The set is much surer, at least in wet years, on the sandy types than upon those containing a high clay content.

The advantage in more regular setting of fruit grown on the residual soils of the Watsonville and Santa Cruz series over the alluvial soils of the Pajaro series is, however, offset by the exceeding productiveness of the latter soils and the larger size of trees and of the apples. This is due to the superior depth, uniform texture, and quantity of humus which these soils contain. These soils are all rather heavy. They form large clods when plowed too dry, but they have the power of conserving soil moisture throughout the dry summer without irrigation, especially when properly cultivated. Single apple trees on these alluvial soils have produced as much as 60 boxes in one season.

Although the majority of the apple trees in the Pajaro Valley are grafted upon French crab-apple stock, different varieties show marked

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variation according to the soil they are grown upon. The large vigorous-growing Yellow Bellflower produces its largest trees, fruit, and crop on the deep, rich, alluvial soils of the Pajaro series, especially on the loam and silt loam. It grows to fair size on the residual Santa Cruz loam and sandy loam and Monterey sandy loam, but is liable to produce small and misshapen fruit and to die back in the tips of branches where these soils lack great depth, humus, or moisture. These same effects on the Yellow Bellflower and other apple trees of large and vigorous growth are found in the sandy loam and loam of the residual Watsonville series covering the plain of the valley. The Yellow Newtown, a much smaller and less vigorous tree, gives much better returns in size of crop and fruit on these shallow residual soils, but the Red Winter Pearmain on account of its hardiness is also well adapted to these inferior soils. The variety best adapted to soils with heavy, cold, or almost impervious subsoils is the Missouri Pippin.

In setting apple orchards in the Pajaro Valley the distances for trees and rows vary with the variety to be grown. The large growing Yellow Bellflower and similar varieties produce best when planted from 30 to 35 feet apart, the wider setting being best suited to the deep, rich, river bottom or alluvial soils and the closer being better in case of the residual or upland soils. Smaller growing varieties, like the Missouri and sometimes the Yellow Newtown, are planted 25 feet apart, especially on the poorer or residual upland soils. Fertilization of the apple blossoms is supposed to be greatly facilitated by planting different congenial varieties close to one another. Under certain climatic conditions cross-fertilization greatly increases the setting of fruit and also the yield. The planting of alternate rows to different varieties secures this result. When large growing varieties like the Yellow Bellflower are alternated with smaller ones like the Yellow Newtown and Missouri Pippin there is greater freedom in tree growth.

Orchards are plowed once or twice in the spring, when a heavy growth of winter weeds consisting of bur clover, alfilaria, white mustard, mallow, and similar weeds are turned under. When these weeds are thoroughly plowed under at this season they do not come up again until the next winter. Summer weeds are not numerous and are almost entirely absent on the heavy soils, thus enabling the orchardist to keep the land clean during the summer with a minimum amount of cultivation. The only exception to this is the morning-glory, which has encroached upon some of the orchards on the heavy dark alluvial soils along the Pajaro River. This weed does not seem to thrive on the sandy and upland soils. It can be eradicated only by persistent cultivation or hoeing during the summer or growing period, never permitting a single green leaf to appear. This process if followed

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once or twice a week during the summer and until frost or winter weather puts an end to its growing period will usually kill out most of it in one year and the remainder can be killed the following year.

Improved tilth, increased size of fruit, and better growth of trees could be secured in some of the orchards on hilly sandy soils by deep plowing and more thorough cultivation before the rainy season is over. This procedure would conserve more moisture, which is sometimes badly needed by orchards on these porous soils.

Between the ages of 6 and 10 years apple trees are expected to begin to bear profitable crops. During the years preceding bearing it has been the practice to grow other crops between the rows. Strawberries, blackberries, loganberries, and raspberries have been the favorite crops. Strawberries die out during the fifth or sixth year and can not be profitably replanted. The bush berries live seven or eight years, when they too die, thus naturally disappearing as the apple trees begin to bear heavy crops. About 60 per cent of the orchards in the valley or bottom lands were in this manner grown to maturity. The remainder of the orchards on the alluvial soils produced potatoes, beans, and sugar beets between the rows of young trees. Irrigation, which was necessary for the berry crops, ceases when the vines die, as it is not considered at all necessary for apple growing, owing to the relatively heavy annual rainfall, deep soil, and cool, moist summers. However, it is believed that furrow irrigation in midsummer would greatly aid in maturing and increasing the size of fruit and of crop on heavily laden orchards.

Fertilization of apple orchards has not proven profitable on the rich alluvial bottom soils. The incorporation of humus by applying barnyard manure and plowing under green manure crops would undoubtedly increase the yields and size of fruit on some of the upland soils.

The apple industry is the principal industry in the Pajaro Valley, the gross income from which is more than $1,500,000 annually. The following list shows the various products from the apple orchards for 1908: Apple shipments consisted of 4,500 cars, or more than 2,300,000 boxes; 750,000 boxes of culls were canned, dried, or made into apple butter, cider, and vinegar; over 2,500,000 pounds of dried apples and 500,000 gallons of cider and vinegar were produced.

OTHER FRUITS.

Apricots find most favorable conditions as to climate and soil in this region. Failure in cropping is seldom known and only one complete failure has been recorded. This fruit is increasing in favor not only on account of the certainty of the crops, but also on account of its size and excellent flavor, rendering it a fine fruit for canning. The

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variety most common is the Royal, but the Blenheim is also a favorite. The fruit not canned is dried and good prices are secured. The profit per acre on suitable soils is considered as good if not better than the average for apples. Thirteen hundred acres are now planted, and planting is steadily increasing.

The soils best suited to this fruit are found in the more sheltered, better drained, hilly or rolling areas, these being usually along the lower slopes of the Santa Cruz Mountains on the eastern side of the valley, the slopes of the Monterey hills on the south side, and the sandier rolling soils of the Watsonville series north of the Pajaro River. These soils rank in their order of excellence as follows: Salsipuedes loam, Corralitos loam, Santa Cruz loam, Watsonville sandy loam, Monterey sandy loam, Santa Cruz sandy loam, and Pajaro sandy loam. In many of the hill areas there are ridges on which the soil is so deficient in humus that apple trees do not do well. Such soils, which are usually light colored or reddish, are generally well adapted to apricots. This is especially true of the Monterey sandy loam and Santa Cruz sandy loam. The apricot also grows well on the steep slopes and little plateaus of the Santa Cruz loam derived from the shale formations. This soil usually contains enough humus for this fruit, which takes kindly to the warm exposure and the disintegrating shale rock.

Persian (English) walnuts thrive in the valley, growing to a very large size. The trees are not planted in solid orchard form but usually as border trees. In this manner from 100 to 200 acres are grown. They produce good yields and are considered very profitable. Deep, rich, alluvial or colluvial soils, such as the Corralitos loam, Salsipuedes loam, and Watsonville sandy loam, are best suited to Persian walnuts. Native California walnuts and eastern walnuts also grow to immense size and the yields are large, but these nuts, though excellent in flavor, are not considered commercial.

Pears have always been grown to a limited extent, but owing to the summer fogs the skin of the fruit is not so smooth nor the flesh so fine grained as fruit grown in the hot interior of the State. The fruit is large, however, and of good flavor and the crops are sure. The pear blight, which has ravaged the interior of the State and caused a scarcity of this fruit with consequent high prices, has not obtained a foothold in this valley.

As the pear crop, especially the highly prized Bartlett, has decreased in quantity, canned pears have become scarce and high in price. The Pajaro Valley pears could be made to fill this market profitably with great assurance of success. The pear blight could be kept out by skillful handling and careful inspection, for the cool climate and strong westerly coast winds, blowing as they do during

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the growing season only from the ocean, apparently tend to keep out the dreaded infection.

The pear grows thriftily and produces well on the hilly areas of the Watsonville sandy loam, loam, and adobe with their clay subsoils, and also on the Pajaro and other apple-producing soils.

About 200 acres are planted in grapes, principally of the vinifera varieties, these being mainly Rieslings (the Chauché Noir, Chauché Gris), and Zinfandel. Others have been found to do fairly well, but as a rule the yields are light. In some well protected, sunny valleys in the Santa Cruz Mountains on the Santa Cruz sandy loam the Flame Tokay has been profitably grown. The Labrusca grapes have proven well adapted to the cool summers and produce large crops of good quality. Inferior or second-grade hill soils are adapted to the Labrusca varieties. The soils of the Watsonville series north and northwest of Watsonville, whether loam or sandy loam, if they have a heavy clay subsoil just below the surface, appear well suited to this grape and seem to offer ideal conditions for it. These soils are well drained on the surface and are sufficiently warm to produce healthy, vigorous vines. A considerable acreage of these soils not now producing good orchard or grain crops could be planted to this grape with profit.

Strawberries became a commercial crop in the valley in 1880, when the Corralitos water system carried water to Watsonville and sold it to irrigators in the Corralitos Valley. From this time on the growing of strawberries and the planting of apple orchards progressed together, for it was and is the common practice to grow orchards to profitable bearing age by cultivating strawberries between the rows. The strawberry acreage varies from 500 to 1,000 acres, and at present is about 600 acres. The extension of permanent orchards has restricted the culture of strawberries, and that industry is now passing beyond the confines of the valley.

Strawberries are produced for four or five years before the plants die out, but it has here never been found profitable to replant them on the same ground. This is true on all soils, except that the vines appear to last longer on the lighter textured soils, like fine sandy loam, sandy loam, and silt loam. It is quite possible that the infertility of land cultivated too long to strawberries is due to lack of crop rotation, rather than to an actual exhaustion of the soil. The application of nitrate of soda would aid in correcting this tendency to self-poisoning of strawberry fields, but would make too large and sappy a growth in vine and berry. Turning under a legume crop like the horse bean, which could be planted between the rows in winter and spaded under in spring, would help, as would a dressing of gypsum. Gypsum has been found elsewhere to aid the beneficial soil bacteria in overcoming deleterious organic soil substances.

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Before planting strawberries the fields are carefully leveled and laid off into checks 200 feet long and about the same in width. A flume is run along the higher side and a 2-inch auger hole bored at each bed. These beds have a row on each side and are separated by a small ditch. The rows are about 20 inches apart and the plants are 15 inches apart in the rows.

After the rains cease in the spring the berries are irrigated weekly, or at least fortnightly, followed by a horse hoe, and finished by hand hoeing. The first year a small crop is secured, but during the next three or four years from 75 to 100 chests of 20 slides of 2 baskets each (about 100 pounds to the chest) are produced per acre. The average is about 100 chests per acre. These chests vary in price from $3 to $10, depending on the time of year. During the present season (1907) as high as $12 was obtained.

The cost of production varies from $200 to $300 an acre. Cultivation and planting for the first year costs $100 an acre, but when the crop is started the fields are contracted to Japanese or Chinese at $1.25 a crate. This includes tending, cultivating, irrigating, and picking the vines for the whole year. One man usually cares for 7 to 10 acres, but requires help during the height of the picking season. The Japanese is usually assisted by his wife and children. The picking season begins in April and continues until January, but the main season lasts only about seven months. The most popular berries planted are the Melinda, of local origin, and the Brandywine.

Strawberries have been grown entirely on the Pajaro group of alluvial soils, and at present the largest acreage is upon the Pajaro clay loam adobe, a very heavy soil which is hard to cultivate. This soil being the worst for apple orchards was the last to be planted to them, and consequently was the last to be left open enough for the culture of the strawberry. The lighter soils of this alluvial group produce better but require more water.

The search for new strawberry lands has caused a demand for some of the soils of the Watsonville group on the low, rolling hills. These soils will do well when irrigation water can be obtained. In some cases it may be beneficial to fertilize with barnyard manure, green manure, etc., to increase the humus and nitrogen. Lime and nitrate of soda may also be added if the growth is poor.

The acreage in blackberries, loganberries, and raspberries is variously estimated at from 500 to 700 acres or more. About half this acreage is devoted to blackberries and the remainder evenly divided between loganberries and raspberries. All these berries are planted, cultivated, irrigated, and marketed in a similar manner. These brambles are planted usually between the rows of young apple orchards which have been carefully leveled for irrigation. Rows are placed 8 feet apart with the bushes 4 feet apart in the rows. They

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are irrigated three or four times during the cropping season, which continues for about four months. The cultivation between the rows is done with a horse cultivator, but some additional hand hoeing is required. Both the cultivating and irrigating are often done by the white help, but the picking is performed by Japanese, who are paid by the crate. Securing labor to pick the crops when they are ripening rapidly is the most serious difficulty encountered in their culture. Enormous crops are easily produced on all the irrigated alluvial soils. The cost of producing these crops varies from $150 to $200 an acre and the gross income from $300 to $600, leaving a net income ranging from $150 to $400 an acre.

The favorite varieties are the Mammoth blackberry and the Cuthbert raspberry. The loganberry, an accidental cross between a cultivated raspberry and a wild blackberry, propagated by Judge Logan, of Santa Cruz, has become a well-known berry of trade. It yields well in the Pajaro Valley, where it is increasing in favor and acreage. The period of productiveness for blackberries and loganberries is about ten years, and for raspberries two or three years less. The raspberry ripens earliest in the season, the blackberry next, and lastly the loganberry. The bulk of the crop is shipped fresh to San Francisco and adjacent points, very little being left for canning, although the demand for such purposes is good.

Cherry trees grow to immense size on the Pajaro sandy loam and the Corralitos loam, but the crop is very uncertain on account of the cool, moist climate of early spring. About 225 acres of cherries, mainly of the Napoleon (commonly known as Royal Anne in California) variety, are grown chiefly for the manufacture of the processed Maraschino cherries.

At one time there were about 1,500 acres in prune orchards in the Pajaro area, but low prices and a rather inferior quality of fruit has caused a decline in production until at present (1908) only 500 acres of the original acreage stands. There is also a small acreage in peaches, about 200 acres, but this fruit does not thrive and the acreage becomes smaller year by year.

SOILS.

At one time the Pacific Ocean covered the present Santa Cruz Mountains. Later, when they were uplifted, the Pajaro Valley became a bay and the San Francisco Bay region and the great interior valley of California became inland seas. When the latter broke through at the Carquinez Straits into San Francisco Bay it caused this body of water to overflow southward through the Santa Clara Valley and finally through the Pajaro Pass into Monterey Bay. A later faulting broke through the mountains at the Golden Gate,

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emptying these waters directly into the Pacific Ocean. By this time the shales and sandstones which largely comprise the rocks and formations of this region had been scalloped into their present shape, forming the Pajaro Valley. Vast quantities of ground-up and disintegrated shales and sandstones had been laid down over beds of gravel and cobbles which formed in the first inrush of detritus from the mountains. Alternating uplifts and depressions in the valley caused recurring submersions which can be readily traced in the alternating layers of sands and clays as well as in the occurrence of the more recent species of shells and mollusks which are found in great abundance at various points 100 feet or more above the valley floor.

The geological formations, consisting mainly of shales and sandstones, are occasionally pierced by intrusions of deep-seated igneous or crystalline rock, like the granite outcrop near Chittenden. The sandstone formations are rather definitely separated from the shales by a line of demarcation closely following a small branch of Green Creek near the Casserly School. The sandstone mountains extend northwesterly to a point in the extreme northern part of the area. Below this dividing line the mountains of the main range consist mainly of shale. The Monterey Hills bordering the southern portion of the valley are largely sandstone with an admixture of shale increasing in quantity as the eastern range is approached. The shales of the valley floor are more or less weathered and disintegrated into soil interspersed with occasional underlying beds of partially cemented conglomerate. The sandstone in the valley is always found adjacent to the sandstone mountains or hills. These formations thus give rise to the residual soils of the area.

Upon these residual soils and formations the Pajaro River and its tributaries have deposited along their courses great quantities of alluvium, thus forming the alluvial or bottom soils. This material has been sorted into various soil types by the action of the river waters. As the Pajaro River drains a region consisting largely of shales, they have imparted to the soils their heavy character from the predominating proportions of clay or silt. Considerable sandy material is added, however, by the tributary streams which rise in the sandstone mountains to the north.

The shales of the hills and valley form residual loams or when slightly washed colluvial loams.

The soils derived from sandstone contain little of the soluble salts known as alkali and very little lime and gypsum. The shales contain soluble alkali salts as well as lime and gypsum, which are frequently mined for cement and fertilizer manufacture. The alkali salts in the shale rocks consist chiefly of the sulphates of soda and magnesia, with smaller amounts of the chlorides of soda and potash. Common

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salt is now found in all the lands covered by the tides. No other so-called alkali salt occurs in the valley.

The alluvial soils have a common origin and are grouped as the Pajaro series. The residual soils are classified in two series—the Santa Cruz series, consisting of the various soils found in the Santa Cruz Mountains, and the Watsonville series, made up of the soils derived from the weathered shales forming the low, rolling hills of the valley floor. In addition, distinct and unrelated soil types occur in various parts of the area.

The following table gives the names and extent of the various soil types in the area surveyed:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Santa Cruz sandy loam	12,300	18.5	Alviso clay	1,536	2.2
Monterey sandy loam	9,600	13.9	Peat	1,216	1.7
Watsonville loam	5,888	8.5	Salsipuedes loam	1,152	1.7
Santa Cruz loam	5,184	7.5	Pajaro silt loam	1,088	1.6
Pajaro loam	5,120	7.4	Dunesand	768	1.1
Santa Cruz sand	4,864	7.1	Pajaro silt clay	640	.9
Pajaro clay loam adobe	4,800	7.0	Pajaro light silt loam	512	.7
Watsonville sandy loam	4,160	6.0	Pajaro sand	320	.5
Pajaro sandy loam	3,840	5.5	Corralitos loam	256	.4
Encina sandy loam	2,240	3.3			
Watsonville clay loam adobe	1,600	2.3	Total	69,120	.....
Pajaro fine sandy loam	1,536	2.2			

Pajaro Series.

The Pajaro soils found along the streams are alluvial or sedimentary in origin and derived from shales and sandstones, with a lesser admixture of detritus from igneous and crystalline rocks. These soils are found mainly along the Pajaro River from Aromas to Monterey Bay in bodies varying in width from 1 mile to over 2 miles. As the river proper drains a large area of shales in San Benito County these soils are heavy in character, varying according to the quantity of silt they contain. They include grades from sand to clay, the lighter soils being found adjacent to the river and the heavier types next the hills. The tributary streams from the sandstone of the Santa Cruz Mountains to the north tend to form principally the sandy loam and fine sandy loam types. The great amount of lime found in all except the sandier types has greatly increased the humus content, giving them a very dark brown or black color. The only exception to this is the recently deposited bodies of silty clay which are rapidly becoming dark with increasing age. The largest bodies of these alluvial soils away from the immediate vicin-

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ity of the Pajaro River are found in the little valleys along the Salsipuedes, Corralitos, Green, and Brown creeks. These alluvial valleys extend to the very base of the Santa Cruz Mountains, varying in width from a few rods at their upper limits to more than a mile. They are generally level, well suited to irrigation, and adapted to a wide variety of fruits, vegetables, and grains.

PAJARO SAND.

The Pajaro sand is a loose, incoherent soil composed of coarse sand and fine gravel, with appreciable quantities of silt. It is light brown in color and more than 6 feet in depth, very porous and quickly dries out in summer. It is very level in topography, having been formed usually at the junction of streams by a rapid rush of large bodies of water. At certain seasons it is too wet and in summer too dry for orchard purposes. Willows, weeds, and native grasses are the common vegetation. A large body of this soil is found above College Lake at the confluence of two streams.

PAJARO SANDY LOAM.

The Pajaro sandy loam consists of a dark-brown sandy loam to a depth of 6 feet or more, and occasionally contains small gravel which sometimes accumulates in pockets in the subsoil. The dark surface soil extends to 30 inches, below which the subsoil becomes lighter in color and texture.

This type of soil is usually easily tilled and is retentive of moisture. It occurs almost exclusively in the long, narrow valleys of Salsipuedes, Corralitos, Green, and Brown creeks. The soil is lightest in color and texture nearest the mountains, becoming darker and heavier as the Pajaro River is approached. Redwoods and large oaks once covered much of this soil. It is an excellent orchard soil, and on account of the sheltered position it usually occupies is especially adapted to the production of early ripening and well-colored fruit of excellent quality. Apples, especially the Yellow Newtown, Lankford, and Red Winter Pearmain, and also cherries, prunes, plums, pears, and Persian (English) walnuts do well in the warm, well-sheltered places nearer the mountains. Strawberries, raspberries, loganberries, and blackberries are grown with excellent results when irrigated. Natural drainage is always good and percolation excellent, generally assuring good crops of apples even in very wet seasons. Cantaloupes, tomatoes, cucumbers, alfalfa, and garden vegetables are successful crops on account of the easy tillage and natural warmth of the soil. On this soil where horsetail (Equisetum) is common the best berries are produced.

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The results of mechanical analyses of samples of soil and subsoil are given in the following table:

Mechanical analyses of Pajaro sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
17094	Soil	0.1	7.0	16.6	37.1	4.9	24.4	9.8
17095	Subsoil	.3	6.1	13.0	36.9	5.7	29.0	8.6

PAJARO FINE SANDY LOAM.

The Pajaro fine sandy loam is a brown or light-brown, micaceous fine sandy loam varying in depth from 18 to 72 inches, the depth being greater nearer the streams from which it was deposited by floods. It usually rests upon a subsoil of black loam or silt loam which was evidently at one time top soil. This heavy subsoil retains moisture well, while the lighter upper soil renders tillage easy. Owing to its excellent drainage and ready percolation the setting of a crop of apples is greatly facilitated.

Small bodies of this type are found west of Watsonville close to Pajaro River and on Corralitos Creek, where an obstruction caused the creek to deposit this soil over the surrounding area. This soil is well adapted to apple culture, producing large crops of good quality. Alfalfa, tomatoes, beans, sugar beets, cantaloupes, cucumbers, and many other truck crops, as well as strawberries, loganberries, raspberries, and blackberries are exceptionally productive.

The following table gives the results of mechanical analyses of this type of soil:

Mechanical analyses of Pajaro fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
17099	Soil	0.0	0.0	0.3	30.0	22.9	38.2	8.4
17100	Subsoil	.0	.0	.0	2.1	13.0	66.8	17.7
17101	Lower subsoil	.0	.0	.0	4.0	12.0	69.5	15.0

PAJARO LIGHT SILT LOAM.

The Pajaro light silt loam consists of alternating layers of light-brown, very micaceous, fine silt and fine sandy loam, to a depth of 6 feet or more, deposited in narrow lenticular bodies upon the bank or lower bench of the Pajaro River. It is occasionally sticky, but is usually fine in texture. On account of its low-lying position it is

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occasionally flooded, but as percolation is excellent it soon dries off when the floods subside. Apple orchards on this soil do fairly well, but it is much better adapted to berries and trucking crops. Berries of all sorts, beans, sugar beets, and garden truck are the principal crops.

The results of mechanical analyses of samples of the soil and subsoil are given in the following table:

Mechanical analyses of Pajaro light silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
17102	Soil	0.0	0.0	1.0	15.9	30.0	44.6	8.6
17103	Subsoil	.0	.2	.6	9.4	21.6	60.6	8.5

PAJARO LOAM.

The soil of the Pajaro loam is a very heavy dark-brown or black loam varying from 12 to 18 inches in depth, underlain to 6 feet and beyond by a light-yellow silt loam which becomes more micaceous with increasing depth. The subsoil over most of this type extends to a depth of 30 feet. Only the finer grades of sand are present except where the type approaches the Pajaro sandy loam, when coarse sand is encountered. Mica, which is common in both soil and subsoil, is largely obscured in the top soil by the large content of humus. This organic matter, together with the generous lime content, usually produces a very mellow condition in this heavy soil. When allowed to become too dry and compact, the plow turns up large clods which necessitate the use of rolling clod pulverizers to reduce them to proper tilth.

Long, irregular bodies of the Pajaro loam occur along the Pajaro River to the ocean and extend a considerable distance up its tributaries in the Corralitos and Green valleys. As it approaches the Pajaro sandy loam it becomes lighter in color and texture, while the reverse is true when it approaches the Pajaro clay loam adobe next to the hills. In separating these two types the change is subsoil from silt loam to heavy silt loam or clay loam was the distinguishing feature. On account of its level topography irrigation is easy. The great depth of the mellow subsoil renders quite easy the percolation of water and penetration of roots. To these factors are due the immense size of the Yellow Bellflower trees and crops. Many of these trees have yielded 50 or 60 boxes per tree in a single season. The fruit, however, is not so good in quality as that grown on the sandier soils.

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As this type is found only in the lower and cooler portions of the valley, it is not well suited to cherries and apricots. Alfalfa, sugar beets, beans, potatoes, and onions are staple crops for this soil, giving immense yields. Strawberries, blackberries, loganberries, and raspberries cover a large acreage, the returns from these varying from $600 to $1,000 per acre, gross. Irrigation is necessary for berry crops in this soil, but on account of the heavy texture a little water will cover considerable ground. Cultivation on the unirrigated lands readily retains the moisture necessary for summer crops.

The following table gives the results of mechanical analyses of samples of soil and subsoil of the Pajaro loam:

Mechanical analyses of Pajaro loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
17108	Soil	0.0	0.4	0.4	7.6	19.5	54.8	16.4
17109	Subsoil	.0	.2	.3	20.8	19.4	46.3	13.2

PAJARO SILT LOAM.

The Pajaro silt loam is a brown, smooth, micaceous silt loam, becoming more micaceous and lighter in color and texture below 3 feet. The subsoil extends to 30 feet or more. The water-carrying power of this type is excellent and its cultivation usually easy, but when allowed to become too dry and packed it often forms large clods. Very little sand and no gravel is found, the type being very uniform in texture. It differs from the Pajaro loam in its low sand content and great increase of micaceous silt, though in position and origin it is similar to the latter type, being derived from weathered and transported shales laid down parallel to the course of the Pajaro River. It is, however, more scalloped by river floods. In structure it is comparable to the Pajaro loam with its top soil washed away, exposing the lighter colored, siltier subsoil. It is very fertile soil, of exceptionable value for apple culture, especially for the Bellflower, Yellow Newtown, and Red Pearmain varieties. The apple trees on this soil are exceptionally large and of fine quality, but are inclined to be somewhat later and more liable to nonsetting of fruit than is usually the case on the sandier types of this series. Alfalfa, sugar beets, beans, potatoes, strawberries, loganberries, blackberries, and raspberries produce immense yields.

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The following table gives the results of mechanical analyses of samples of soil and subsoil of the Pajaro silt loam:

Mechanical analyses of Pajaro silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
17104	Soil	0.0	0.1	0.1	10.6	22.2	53.3	12.7
17105	Subsoil	.0	.1	.1	5.5	11.7	64.9	16.9

PAJARO SILT CLAY.

The Pajaro silt clay consists of light-yellow or drab, plastic silty clay varying from 12 to 36 inches in depth, overlying dark loam or silt loam, which was recently the top soil. This material is derived from recently weathered shales carried down by the Pajaro River and deposited during flood seasons in low depressions or ancient channels near the river, wholly covering the former soils. During the first few seasons after this deposit has been completed crops can not be grown upon it, for the reason that the soil checks into blocks 2 to 3 feet in diameter, the cracks extending a like distance into the earth, usually to the underlying soil. A rank growth of willows first appears, followed later by weeds. From the bottom of the cracks vegetation also springs up, gradually adding to the rotting vegetation which is forming humus. These unfavorable soil conditions are overcome and the land brought into a cultivable state by feeding cattle over it, thus breaking up the blocks and working straw and manure into this harsh soil. Disk cultivators are then used to cut it up sufficiently for a crop of barley. During the next season it is usually fit for beans or sugar beets. The material by this time frequently loses its stiff clay character and becomes more like a mellow silt loam, which is adaptable to a number of crops.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of the Pajaro silt clay:

Mechanical analyses of Pajaro silt clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
17106	Soil	0.0	0.3	0.6	2.4	1.5	65.3	29.0
17107	Subsoil	.2	1.8	2.1	6.7	5.1	58.0	26.7

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PAJARO CLAY LOAM ADOBE.

The Pajaro clay loam adobe is a tenacious, plastic black clay loam, cracking when dry into characteristic adobe cubes. In depth this black soil extends to 3 feet and is underlain by a compact and tenacious yellow clay loam or silty clay loam which permits of slow percolation of either rain or irrigation water. This adobe soil differs widely from the type elsewhere in the State in the entire absence of a marly layer between the subsoil and soil, which acts like a hardpan. As in case of the other members of the Pajaro River soils, it is composed of weathered shale, the finest or clay particles of which were deposited in the more quiet water against the hills. These soils are usually of lower elevation than those farther out in the valley and nearer the river.

This soil contains large amounts of lime and humus and is fairly easy to cultivate if tilled at the proper time, otherwise it breaks up into immense clods. On account of poor natural drainage it is often covered with water for a considerable time, especially in wet seasons. This does serious injury to the roots of apple trees, often killing them, and likewise favors the apple fungus which attacks and destroys trees in such locations. Alfalfa is also affected by this water-logging of the soil. These adverse conditions could be greatly improved by deepening and opening up the natural drainage channels next to the hills where this soil occurs. In many orchards and fields the placing of tile drains at proper intervals and connecting them with the drainage ditches would completely remove this trouble. While apple orchards are successfully and profitably grown on this black adobe, the fact remains that they are much more subject to injury from poor drainage, loss of crop through nonsetting of the fruit, and fungus in roots and trunks than on soils better drained and more favorably located. The woolly aphis, an insidious apple pest, on roots and branches, does most injury in this heavy soil.

The advantages of this soil, however, are its natural fertility and its great moisture-retaining properties. It is one of the best soils in the area for the production of strawberries with the use of irrigation water. Loganberries, raspberries, and blackberries are almost equally as profitable. Sugar beets, onions, potatoes, beans, and barley yield immense crops. Alfalfa on the better drained portions produces three or four good crops, especially when irrigated. On this prolific soil 26 tons of sugar beets and 150 sacks of potatoes per acre have been secured without the aid of irrigation or summer rains. Such yields were made possible by thorough cultivation, and by practicing a three-year rotation of sugar beets, beans, and barley or potatoes.

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The following table gives the results of mechanical analyses of samples of soil and subsoil of the Pajaro clay loam adobe:

Mechanical analyses of Pajaro clay loam adobe.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
17114	Soil	0.0	0.5	0.2	4.6	12.6	55.5	27.0
17115	Subsoil	.0	.2	.2	6.8	22.2	57.2	13.1

The following sample contained more than one-half of 1 per cent of calcium carbonate ($CaCO_3$) : No. 17115, 5.22 per cent.

Santa Cruz Series.

The Santa Cruz series of soils is derived from the weathering and decomposition of shales and sandstones in place. These soils are found in the Santa Cruz Mountains and consist of three types—a red sand near the seacoast, a sandy loam from the sandstone mountains, and a loam from the shales in the same region. On the hills covered with the sand only grass and weedy shrubs are found, but the sandy loam and loam of the steep hills or mountains are covered with redwoods, firs, several species of oaks, madroña, laurel, and other trees, with a thick undergrowth of chaparral.

SANTA CRUZ SAND.

The Santa Cruz sand is a loose, incoherent sand 6 feet or more in depth, underlain by disintegrated sandstone at varying depths according to the topography. The first 3 feet show considerable organic matter, which gives the soil a dark-red or reddish-brown color. The color becomes a light red in the subsoil where there is usually an increase in the silt content.

This type occupies a spur of the Santa Cruz Mountains and, starting at Port Watsonville, passes northward parallel to the bay, joining the mountain range in the northern part of the area. This spur has undoubtedly been submerged in comparatively recent geological times as indicated by seashells found at 100 feet or more above the sea. The rounded hills, together with the lack of clay in the soil, tend to confirm this view. No trees appear on this soil except at its junction with the Santa Cruz sandy loam. Oats and Indian corn are the only cultivated crops and the yields are light. Wild radish, sorrel, foxtail, and broncho grass commonly cover uncultivated, neglected fields. Although this soil is wholly unfit for orchards or vineyards it is well adapted for the culture of eucalyptus trees, producing where tested fine groves of vigorous trees. It is probable that these trees would

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give greater returns than the light crops of grain now grown, on account of the ability of the trees to condense the summer fogs which daily blow in from the sea.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of the Santa Cruz sand:

Mechanical analyses of Santa Cruz sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
17112	Soil	0.0	3.7	22.0	58.0	5.1	4.8	7.0
17113	Subsoil	.0	3.5	18.5	56.0	7.2	8.7	6.5

SANTA CRUZ SANDY LOAM.

The Santa Cruz sandy loam consists of a loose dark-red or reddish-brown sandy loam to a depth of 2 or 3 feet, underlain by lighter reddish-colored subsoil, which becomes heavier in texture with increasing depth, until partially decomposed sandstone is reached at depths varying from 4 to 20 feet according to its position on ridge or slope. Being often quite sandy in the upper soil layers, it permits rapid penetration and frequently considerable washing by heavy rains. The heavier subsoil, however, is much more retentive of moisture than the top soil, which when cultivated at the proper time forms an excellent moisture-retaining mulch, even on steep hillsides where orchards and vineyards are grown.

Over this type of soil are scattered many small farms, which are usually planted to orchards and vineyards, with occasional fields of grain and gardens. On account of the warmth of this soil, its iron content, excellent drainage, and protection from chilling fogs, fair fruit crops of uniformly high color and early maturity are grown. The codling moth, for these same reasons, is also much worse here than elsewhere and the trees must be sprayed more frequently. Apples of the red varieties, such as the Red Winter Pearmain, Smith Cider, etc., and the Yellow Newtown all give good and steady returns. Vinifera grapes of the Chauché Noir, Chauché Gris, and Zinfandel types are grown almost exclusively, making excellent dry wines, which are largely consumed in the region. The growth and maturity of vinifera grapes is here made possible by the increased warmth and protection afforded by the mountain vales. In its native state this soil was in many places covered with a dense growth of redwood, live oak, and chaparral. The chaparral consisted mainly of manzanita, madroña, wild lilac, and other shrubs. The redwood soils produce the best orchards.

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The average results of mechanical analyses of samples of soil and subsoil of this type are given in the following table:

Mechanical analyses of Santa Cruz sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
17082, 17953	Soil	0.3	17.4	22.5	36.0	3.4	10.0	10.3
17083, 17954	Subsoil	1.0	16.4	15.6	27.3	6.6	18.7	14.3

SANTA CRUZ LOAM.

The soil of the Santa Cruz loam to a depth of about 30 inches consists of a dark-brown or brown gritty loam filled with lenticular pieces of shale from which it originated. This dark soil is underlain by yellow or drab subsoil which becomes siltier in texture with depth until silt loam is often encountered, especially in the northwestern part of the area toward the region about Aptos. This subsoil usually carries more shale than the upper soil and partially weathered shale is frequently found at depths ranging from 5 to 10 feet, according to the position on hilltop or slope. Both soil and subsoil show tendencies toward adobe structure, especially during the dry season.

Redwoods are often seen on the higher ridges and are usually found in every ravine or creek together with chaparral. In favored localities these slopes and ravines produce good apple orchards which yield regularly fair crops of finely colored fruit. On the lower slopes, back from the sea, excellent crops of apricots are produced with great regularity, being seldom injured by frost. The more exposed slopes are covered with native grasses. The larger body of this type occupies the ridges and slopes of the shale mountains in the eastern part of the area north of Chittenden, but similar bodies occur in the northern part on the spurs running south from the main range.

The following table gives the results of mechanical analyses of samples of soil and subsoil of the Santa Cruz loam:

Mechanical analyses of Santa Cruz loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
17119	Soil	1.1	8.6	8.6	30.1	5.2	23.9	22.0
17120	Subsoil	2.7	14.9	10.6	20.1	13.9	23.5	13.6

WATSONVILLE SERIES.

The soils of the Watsonville series are residual in origin and occupy the plain of the valley, consisting of low, rolling ridges and hills

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north of the Pajaro River. This plain is traversed by several long, narrow valleys of the Pajaro series of soils. In the northern part of this plain ridges of the Watsonville soils approach the shale and sandstone mountains of the high range surrounding the valley, and are more or less sharply separated from the Santa Cruz series by the Larkin and other valleys. The Watsonville soils become sandier as the Santa Cruz Mountains are approached, forming a sandy loam type, while the main plain consists of a loam and the lower portions next the streams or low-lying valleys become an adobe type. The main body of soil is derived from decomposed and disintegrated shales, with occasional beds of conglomerate appearing.

WATSONVILLE SANDY LOAM.

The Watsonville sandy loam is a reddish-brown tenacious sandy loam, 30 inches deep, underlain by a dark-red sandy loam finer and heavier in texture and filled with particles of sandy shales to 6 feet or more in depth. Occasionally a layer of heavy silty clay loam from decomposed shale is encountered at 4 to 6 feet, rendering it rather impervious to roots and water. The sand in this soil is sharp and angular, causing the soil to become very hard and compact when dry. In the subsoil this angular sand causes it to assume a sandy adobe character, which is often mistaken for hardpan. Iron salts also add a cementing material which gives it a mottled rusty appearance.

The native growth on this type consists mainly of scattered live oaks and wild grasses. Sorrel is plentiful, indicating a lack of lime. Grain is the common crop over a large proportion of this type. When grain crops were largely replaced by orchards on the richer alluvial soils, orchard planting soon extended to these upland soils. With deep and thorough cultivation, the orchards have made a fair growth. On account of the drainage afforded by both the topography and subsoil, the fruit is surer in setting than on soils in the lower valleys. The soil would be greatly benefited by growing and plowing under leguminous crops like peas, vetches, or horse beans. Barnyard manure and also a dressing of 300 or 400 pounds of lime or gypsum per acre would be very beneficial. Where no legumes or nitrogenous material is plowed under, a dressing of 150 pounds per acre of nitrate of soda would undoubtedly increase the size of trees and of fruit, both being somewhat inferior in this respect.

In planting apple orchards such large growing trees as the yellow Bellflower should be avoided, and smaller growing trees like the Yellow Newtown and the Missouri Pippin should be selected. On the better and deeper portions of the type apricots have proved thrifty and productive. In the steeper positions, where orchards can not be grown profitably, eucalyptus trees have shown remarkably good growth, especially the blue gum (*Eucalyptus globulus*). Amer-

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ican grapes of the Isabella variety have proven especially thrifty and productive.

The following table gives the results of mechanical analyses of samples of the soil, subsoil, and lower subsoil of the Watsonville sandy loam:

Mechanical analyses of Watsonville sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
17955	Soil	0.1	3.1	4.5	17.5	7.2	55.8	11.3
17956	Subsoil	.3	3.4	3.5	40.9	20.3	11.7	19.0
17957	Lower subsoil	4.1	9.3	20.9	39.0	2.7	13.7	11.0

WATSONVILLE LOAM.

The Watsonville loam is somewhat similar to the Watsonville sandy loam. It is darker in color and heavier in texture in both soil and subsoil and occurs lower down the slopes of the hills. The soil consists of a heavy, gritty dark-brown or dark-gray loam 20 inches in depth, underlain by a heavy reddish-yellow clay loam subsoil to 3 or 4 feet. This subsoil is heaviest directly under the top soil and is locally called hardpan. Underlying this in turn is a gray, gritty layer of partially disintegrated shales forming a clay loam or loam. In this subsoil gravel of various sizes occurs, often forming into pockets and gravel beds of considerable size and extending to unknown depth.

This type of soil occupies the lower portions of the hills and ridges not covered by the Watsonville sandy loam, and also the whole of the low hills in the vicinity of the group of lakes 2 or 3 miles south of Watsonville, and extends from the town of Watsonville easterly almost to the mountains.

Scattered live oaks and native grasses grow on this type, but improper cultivation and pasturage has produced a growth of cheat, broncho grass, wild oats, apple thistle, tarweed, and sorrel which has well-nigh ruined the grain fields.

A considerable portion is now in apple orchards and the remainder in grain and pasture. Raspberries, blackberries, and a few strawberries are grown where irrigation can be practiced. More berries will in the future be planted on this type of soil on account of the growing scarcity of the favored alluvial soils. The pear trees yield remarkably well, but the fruit is rough, being much better for canning than for shipping purposes. On account of the almost impervious layer of clay in the upper subsoil the apple trees show an inferior growth and the fruit has a tendency to be too small. The

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smaller trees, like the Missouri Pippin and the Yellow Newtown, especially the former, are to be preferred on this soil, giving much better results in size and quality of fruit than varieties of larger growth. Pear trees are not materially affected by the heavy subsoil and produce well.

Though this soil has excellent surface drainage, it has exceedingly poor percolation and underdrainage. Tile drainage would greatly benefit the orchards on much of this type, as it would prevent the soil from becoming cold and water-logged during particularly wet weather. Though much more humus exists in this soil than in the Watsonville sandy loam, it would nevertheless be greatly benefited by growing lugume crops for green manure or by applying barnyard manure. A dressing of 300 pounds of lime and 150 pounds of nitrate of soda per acre would sweeten and invigorate this soil, and the good results would be seen in the more thrifty growth of apple orchards and the larger yields of fruit. Isabella and other Labrusca grapes thrive and are almost wholly resistant to the mildew so common on this soil.

The following table gives the results of mechanical analyses of the soil and subsoil of this type:

Mechanical analyses of Watsonville loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Veryfine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
17110	Soil	1.3	6.5	9.3	22.3	11.7	26.9	22.0
17111	Subsoil	.9	7.2	10.2	23.4	7.8	26.9	23.6

WATSONVILLE CLAY LOAM ADOBE.

The Watsonville clay loam adobe is a residual soil derived from decomposing shales like the preceding types of this series. It occupies the lowest hills and their slopes adjacent to the Pajaro or river soils and often surrounds some of the small lakes and swamps. It is found mainly west of Watsonville on the low hills surrounding the Peat soils and in the vicinity of College Lake. The soil consists of 20 to 30 inches of black or very dark-brown clay loam adobe or sandy clay adobe and is underlain by a yellow gritty clay loam to 4 feet, at which depth is encountered a partially decomposed shale intermingled with gravel and shale fragments to a depth of 6 feet or more.

This type of soil in its native state has no tree growth. It produces a poor stand of wild grasses mixed with wild oats, sorrel, and apple thistle. In favored places foxtail, bur clover, and alfilaria grow well. Grain crops are grown on some portions, but as the yields are small such crops are mostly cut for hay. Pears are the only orchard

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crop adapted to this soil, and good yields could be made. Eucalyptus trees have made very good growths on this heavy soil and would no doubt yield better returns than some of the present crops grown on it.

The following table gives the results of mechanical analyses of samples of soil, subsoil, and lower subsoil of this type:

Mechanical analyses of Watsonville clay loam adobe.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
17116	Soil	0.2	0.8	0.9	12.8	16.9	46.6	22.1
17117	Subsoil	2.4	8.4	6.6	14.4	7.7	32.7	27.8
17118	Lower subsoil	.5	2.3	1.6	11.1	11.8	48.4	23.8

MISCELLANEOUS SOILS.

SALSIPUEDES LOAM.

The Salsipuedes loam consists of a dark-brown gritty loam 3 feet deep, underlain by a brown or light-brown loam or heavy sandy loam filled with waterworn gravel and pieces of shale to a depth of 6 feet and more, often 10 or 12 feet, where the underlying shale or soil of a different character is encountered. This soil is colluvial in origin, having been washed down from the shale mountains and adjacent hills. It merges rather abruptly into the Watsonville sandy loam on the one hand and the Santa Cruz loam on the other. Oak, redwood, sycamore, willow, alder, and brush are naturally found on this soil.

Fine apple, prune, and apricot orchards are to be seen over the greater part of this type. The soil is especially well adapted to apricots, and by far the largest apricot orchard in the valley is grown on it, producing regularly fruit of fine size and quality. In a sheltered portion against the hills is found a small productive lemon orchard.

The following table gives the results of mechanical analyses of samples of the soil and subsoil of this type:

Mechanical analyses of Salsipuedes loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
17121	Soil	1.7	6.4	4.9	19.4	10.8	41.0	16.1
17122	Subsoil	.9	4.0	5.3	22.6	15.6	33.1	19.0

CORRALITOS LOAM.

The Corralitos loam occurs as an isolated, oval-shaped body of alluvial loam on the Corralitos road, beyond Whiskey Hill. The soil

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is a smooth, mellow, chocolate-brown micaceous loam 3 feet in depth, underlain by a light-brown or yellowish-brown micaceous loam to a depth of 30 feet. It is very uniform in texture, with good percolation, drainage, and moisture-retaining powers, making it in all respects an ideal orchard soil. It is derived from the washings from the rotted shales of the adjacent hills intimately mixed with alluvium from Corralitos Creek. Stumps of gigantic redwood trees cut twenty or thirty years ago are still seen in the fields and orchards, many of them being surrounded by circles of second growth or sucker trees, now 60 feet or more in height.

Orchards cover the entire type, the apples predominating, though apricots, cherries, prunes, and Persian (English) walnuts are common and produce trees of immense size. The productiveness of this soil gives it a high value. One 40-acre apple orchard of Yellow Newtown produced a crop which sold on the trees for $10,000, and the packer who bought it made as much more. Vegetables, berries, and all other crops adapted to the area do well on this soil.

The results of mechanical analyses of samples of the soil and subsoil are given in the following table:

Mechanical analyses of Corralitos loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
17084	Soil	0.1	3.0	5.4	22.1	5.4	45.2	18.7
17085	Subsoil	.2	2.6	8.2	24.6	5.1	41.4	17.1

MONTEREY SANDY LOAM.

The Monterey sandy loam occurs in the hills to the south of the Pajaro River and extends from Aromas westward to the ocean. The soil is a brown fine sandy loam darkened by humus to 30 inches in depth, underlain by a red-brown sticky sandy loam to 4 feet, where partially decomposed sandstone is usually encountered, which in turn gives way to an ashen-gray shaly sandstone or alternating layers of gray shaly sandstone and red sandstone to an indeterminate depth.

As this type approaches the main mountain range to the east it becomes more broken and hilly and is covered with live oak, madroña, chaparral, and other brush, especially on the eastern and northern exposures, where the wind and sun can not strike. The exposed slopes are covered with grass. On the ridges and steeper slopes the soil is light brown from loss of humus, which accumulates in the lower slopes or in the soil below, giving it a much darker color. These conditions favor the growth of apple and apricot trees, which are planted and give profitable returns. The apple is much more sensitive to the lack of humus in the soil than the apricot, which is often found

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growing well in light-colored soils where apples entirely fail. As the ocean is approached trees and brush give way to grass and the topography becomes more even, and instead of orchards are seen fields of oats and barley or by-pastures. The underlying sandstones are here more horizontal and impervious to water, which accumulates in small ponds throughout the year. This condition of the sandstone in the subsoil renders the soil unfit for orchards, which soon show "die-back" in the tips of the branches and a corresponding lack of vigor.

On the better portions of this type where orchards are planted the soil could be greatly improved by growing and plowing under green manure crops to increase the humus content which is so essential for the production of apples. Barnyard manure and lime would also have a beneficial effect. This soil should be well cultivated early in the spring, before the end of the rainy season, in order to conserve the winter moisture by maintaining a few inches of loose soil mulch. This practice would undoubtedly result in increasing the size of the fruit, which is sometimes too small. This soil is best suited to apricots, and produces in favored locations highly colored early-maturing fruit. Mildew and scab are almost entirely absent, but the codling moth is destructive owing to the sheltered position of the orchards.

The following table gives the results of mechanical analyses of samples of soil, subsoil, and lower subsoil of this type:

Mechanical analyses of Monterey sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
17096	Soil	0.1	7.0	22.4	35.3	1.7	23.1	10.3
17097	Subsoil	.3	7.9	24.9	33.7	1.6	23.8	7.4
17098	Lower subsoil	.1	10.4	24.1	24.1	1.4	21.4	18.4

ENCINA SANDY LOAM.

The Encina sandy loam is a residual soil occurring in the region of Elkhorn Slough on the southern slope of the Monterey Hills. The soil consists of a dark-brown or drab-gray, sticky, coarse sandy loam 24 inches deep, underlain by a gray, heavy, sandy loam or sandy adobe to 4 feet, at which depth the subsoil becomes a reddish, coarse, sandy clay or loam to the underlying shales. Throughout both soil and subsoil are scattered sharp angular fragments of quartz and granitic gravel together with fragments of shale. The sharp, angular gravel and sand give the soil a tendency to pack, which is its worst feature.

The sloping topography of the type insures good surface drainage. Large live oaks and grass constitute the principal growth on the type. Some grain is grown with partial success, much of it being cut for

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hay. The only apple successfully grown is the Missouri Pippin, and a few Royal apricots are also produced.

The results of mechanical analyses of soil and subsoil are shown in the following table:

Mechanical analyses of Encina sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
17948	Soil	2.1	13.9	19.7	26.5	13.7	16.7	7.5
17949	Subsoil	3.9	18.0	22.9	25.4	8.9	15.6	5.7
17950	Lower subsoil.	1.8	12.0	18.6	24.2	10.4	17.2	15.5

PEAT.

Peat occurs in the low depressions and swamps along Larkin Creek and its tributaries among the low hills west of Watsonville. It has its origin in the swamp, caused by the heavy deposits of alluvium laid down by the Pajaro River across the mouth of Larkin Creek during seasons of flood. These swamps were shallow and filled with a heavy growth of tules, cat-tails, and other water-loving plants. The rotting of these plants kept pace with the deposits of alluvium until black, fibrous, homogeneous Peat was formed several feet deep. The winter rains continually washed some fine soil and sand from the surrounding hills, thus adding considerable inorganic material and giving this Peat a much heavier character than is usual for Peat soil. The organic and inorganic contents are as follows:

Chemical analyses of Peat.

Depth.	Organic content.	Inorganic content.
Feet.	*Per cent.*	*Per cent.*
0-1	24.72	75.28
1-2	24.11	75.89
2-3	22.11	77.89
3-4	21.03	78.97
4-5	21.28	78.72
5-6	19.32	80.68

Considerable quantities of gypsum and other sulphates, together with the carbonates of lime and magnesia, have been accumulated from the evaporation of river waters held in these swamps. When the excess of water was drained off the newly formed soil quantities of these salts accumulated on the immediate surface in the form of a white crust. The soil as a whole contains no injurious amounts of

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salts, but in places the first inch or two of surface soil shows injurious quantities. By plowing the land and thus distributing this excess through the first foot of soil its effect is not noticed. The quantity can be greatly decreased by better drainage through the open ditches and surface flooding during the wet season. The following analyses show these salts to be composed largely of gypsum and potassium sulphate, which are largely used as fertilizers:

Chemical analyses of Peat from Pajaro area, 2 miles west of Watsonville, Cal.

Constituent.	Per cent.	Constituent.	Per cent.
Ions:		Conventional combinations:	
Calcium (Ca)	18.07	Calcium sulphate ($CaSO_4$)	61.42
Magnesium (Mg)	7.88	Magnesium sulphate ($MgSO_4$)	31.48
Potassium (K)	1.54	Magnesium chloride ($MgCl_2$)	.58
Sulphuric acid (SO_4)	68.16	Magnesium bicarbonate ($Mg(HCO_3)_2$)	4.71
Chlorine (Cl)	.44	Magnesium (Mg), left	.27
Bicarbonate (HCO_3)	3.92	Potassium (K), left	1.54
Phosphoric acid (PO_4)	Trace.		
		Per cent soluble	2.98

When these Peat areas were first drained, by cutting a deep channel for Larkin Creek through to the ocean, immense crops of onions, potatoes, and grain were produced. As is usual with this type of soil, the yields soon declined to such an extent that these crops were no longer profitable and much of the land was allowed to revert to grass. When beans were introduced in a crop rotation with onions or potatoes good crops could be grown, but when grain crops were used in rotation with onions or potatoes the soil soon became unproductive. On examination nitrogen was the only plant food found deficient, and it is therefore probable that the plowing under of some legume crop or the addition of nitrate of soda would be very beneficial. The addition of fresh barnyard manure has also been found very efficient in renewing this soil. A crop rotation including a legume like beans or peas is important if the productivity of the Peat soil is to be maintained.

Rye grass is a natural grass crop for this soil. Stock beets and sugar beets do well, but the sugar beets are too low in sugar content and purity for any use except stock feed. Celery and asparagus would be perhaps the most profitable crops on this soil provided proper care is exercised in preventing the inroads of rust.

ALVISO CLAY.

The Alviso clay is found near the seacoast where tides at times cover the land. It occurs along Elkhorn Slough and along Larkin Creek near its mouth. The soil is alluvial in origin and is usually a drab plastic clay or silty clay to 6 feet in depth interspersed with layers of light-colored clay loam. Pickleweeds, rushes, and tules

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grow in the overflow portions, while salt grass, cressa, atriplex, and water foxtail grow on the drier portions. On the portions protected by levees and later washed with fresh water, crops of barley have been grown, otherwise it is an unproductive salt marsh containing over 3 per cent of sea salts. Portions of it are used for salt production by evaporation in shallow basins containing sea water.

The results of mechanical analyses of samples of the soil and subsoil of the Alviso clay are given in the following table:

Mechanical analyses of Alviso clay.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
17946	Soil	0.0	0.4	0.7	2.3	0.4	52.3	44.7
17947	Subsoil	.0	.4	.9	2.9	3.4	52.0	40.9

DUNESAND.

Dunesand occurs in a long, narrow ridge along the coast from Port Watsonville to Mass Landing, broken only by the narrow opening made by the Pajaro River where it flows into the sea. This ridge of Dunesand is about 30 feet high and much of it is covered with bush lupines, wild verbenas, mesobrianthemum, and similar plants, which hold the sand as it blows up from the beach. Where these are absent it has been found advantageous to plant sand-binding grasses to hold this ridge in place.

IRRIGATION AND WATER SUPPLY.

Irrigation in the Pajaro Valley is unnecessary for any crop but berries. The berry crops, whether strawberries, blackberries, raspberries, or loganberries, require water during the growing and producing season, which extends throughout the dry months from May until October. At one time or another a large part of the valley has been under irrigation, for it has been the custom to grow irrigated berries between the rows of apple trees for the first eight or ten years, or until the trees are in profitable bearing. In addition to the berry crops, alfalfa is also irrigated to increase the tonnage, although it produces fine crops of hay without it.

No residual or upland soils are now being irrigated, but this may be done with profit in time to come, when the increasing size of the orchard trees has made berry growing an impossibility on the low alluvial soils.

Some of the Watsonville sandy loam and Watsonville loam on the low, rolling valley hills may be greatly helped by furrows carrying irrigation water during the summer, when the trees are growing fast

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and producing a crop of fruit. The size of both apple and tree would be increased and fruit made marketable, which would otherwise be too small.

As the lakes and streams of the Pajaro Valley are all considerably below the level of the land, no gravity irrigation water can be obtained. Pumping is, therefore, the sole source of supply for irrigation. The lakes among the hills, the Pajaro River, and wells furnish the supply for the pumps. The principal lakes used for this purpose are Pinto, College, and a small one near Whiskey Hill. These furnish approximately 2,000 gallons per minute during the time the pumps are running. As the water must be pumped uphill for a considerable distance, the cost for berries is high, as they are irrigated every three weeks during the cropping season. One miner's inch (1 square inch of water under a pressure of 6 inches) is expected to irrigate an acre of strawberries throughout the dry season.

Most of the stream water used for irrigation is pumped from the Pajaro River, and as this stream drains not only the Pajaro Valley, but also a large portion of San Benito County, a great quantity of water is always available. The water is pumped out of the river and up the banks by a lift of between 20 and 40 feet. Pumps having an estimated capacity of 5,700 gallons per minute and irrigating about 600 acres of berries and some alfalfa are supplied from the river during the dry season. Many of these pumps are run by steam, others by gasoline and electricity. The capacity of the river has not yet been taxed to its utmost, even when pumping is at its height and the river at its lowest. Summer dams put entirely across do not stop the river's flow, for it continues underground through the porous sand and gravel in its bed.

Corralitos and Brown creeks supply the towns of Watsonville and Freedom and vicinity with water for domestic and irrigation purposes. Reservoirs, holding 10,000,000 gallons, preserve a perpetual supply under good pressure, and from this source many of the berry fields in the Corralitos Valley receive their irrigation water.

Pumping from bored wells is much cheaper and more efficient when these can furnish a sufficient supply of water. More than a dozen pumps in wells averaging 162 feet in depth, pumping approximately 4,800 gallons per minute, with an average lift of 20 feet, deliver water to over 500 acres of land, mainly in berries, with some few acres of alfalfa. Gasoline furnishes most of the power for these pumps; electricity the rest. The area in which wells can be secured with sufficient water for pumping is confined to the alluvial soils in a strip along the Pajaro River and along the Salsipuedes Creek near Freedom. Even here the belt is very narrow and sharply defined, a few feet often sufficing to cause a failure in water supply. No good wells

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are found close to the hills on either side of the river, but are found between a point some distance above Vega and the ocean on both sides of the river. The best wells are usually on the south side of the river. Between Watsonville and Pajaro and the ocean artesian wells are obtained, flowing varying amounts, and one also in Salsipuedes Creek. These are pumped to increase their flow.

Beginning at the point where artesian water is found, the water level in the wells is of the same general level or altitude above the sea, showing definitely that all this body of pumping water is connected. The depth of all the wells varies but little from 160 feet. The formation of the valley is like a long oval trough, full of cobbles and gravel and sand, which was later covered with alluvium of varying texture. As the hills on either side are approached the bed rock, or bottom, is encountered. This bottom is composed of partially decomposed red sandstone of the Monterey hills to the south. No shale is encountered in boring wells.

From the sources described—the lakes, rivers, and wells—more than 1,300 acres in the Pajaro Valley are irrigated. The cost of water per acre each season when compared with the price obtained for the crops produced is comparatively cheap. The value of the crops from this irrigated land averages from $300 to $1,000 per acre.

Approximate estimates of irrigated land as given below are taken from the records of S. Marcus, of Watsonville:

Source.	Gallons per minute.	Acres irrigated.
Lakes	2,000	200
Pajaro River	5,700	600
Pumped wells	4,800	500
Total	12,500	1,300

The quality of the irrigation water varies considerably. The water pumped from the lakes is quite free from soluble salts, averaging only 25 parts per 100,000—low average. The Pajaro River water, originating largely from the shales of San Benito County, which contain considerable amounts of soluble salts, has at stages of low water, or during the irrigating season, as high as 75 parts per 100,000 of soluble salts. While this is not an injurious amount under ordinary conditions for crops and soils, it does at times seriously affect the shallow-rooted strawberry on heavy adobe by accumulating along the edges and sides of the trenches and finally injuring the berries grown on the crown of the ridge. Where the water flows in the trenches these salts are washed downward and away. During ordinary winters the rainfall washes away the greater portion of these accumula-

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tions, but during exceedingly wet winters the adobe soils soon become saturated with water which is prevented from passing away by the poor regional drainage, and the water table is held almost at the soil surface, thus preventing the passage of the salts downward. On the return of warm dry weather they again appear on the surface as incrustations. Lighter textured soils, like the Pajaro silt loam, Pajaro fine sandy loam, and Pajaro sandy loam, do not show these accumulations, even though irrigated by the same water. This is due to their more porous texture and better drainage, which carries away all excess accumulations.

The following table gives the chemical composition of the waters used for irrigation in the Pajaro Valley:

Analysis of irrigation waters.

Constituent.	Corralitos, artesian well.	Vega, pumped well, Eatons.	Vega, pumped well.	Watsonville, Pajaro River.	Pajaro, 2 miles south, pond.
	Parts per 100,000.	*Parts per 100,000.*	*Parts per 100,000.*	*Parts per 100,000.*	*Parts per 100,000.*
Ions:					
Calcium (Ca)	4.3	5.7	6.4	1.4	2.0
Magnesium (Mg)	1.7	7.4	5.9	4.8	2.1
Sodium (Na)	2.6	3.1	43.0	14.8	1.5
Potassium (K)	1.4	4.2	3.2	5.1	1.3
Sulphuric acid (SO_4)	4.9	4.9	7.4	9.1	.8
Chlorine (Cl)	1.7	5.1	67.4	7.6	1.7
Bicarbonic acid (HCO_3)	21.8	54.5	42.4	32.4	18.2
Conventional combinations:					
Calcium sulphate ($CaSO_4$)	6.9	6.9	10.5	4.8	1.1
Magnesium sulphate ($MgSO_4$)	.....	.....	.....	7.2	.....
Magnesium chloride ($MgCl_2$)	.....	.....	23.1	10.2	.....
Calcium chloride ($CaCl_2$)	2.7	8.0	9.1	.....	2.6
Potassium chloride (KCl)	.....	.....	6.1	.....	.....
Sodium chloride (NaCl)	.....	.....	68.5	.....	.....
Calcium bicarbonate ($Ca(HCO_3)_2$)	5.3	3.2	.....	.....	3.0
Magnesium bicarbonate ($Mg(HCO_3)_2$)	10.3	44.6	.....	4.5	12.1
Potassium bicarbonate ($KHCO_3$)	3.6	10.7	.....	13.0	3.3
Sodium bicarbonate ($NaHCO_3$)	9.6	11.5	58.4	35.5	5.5
Total solids	33.4	84.9	175.7	75.2	27.6

From this table it is seen that there exists quite a variation in the soluble salt contents. Those showing the higher amounts seriously affected certain spots in the strawberry fields. On account of the large proportion of lime and gypsum in the irrigation waters, the injurious effects of the soluble salts are greatly reduced. In addition, considerable potash exists, and acts as a fertilizer with the lime and gypsum. The remaining salts exist mainly as bicarbonates and chlorides of soda and magnesia. In places considerable quantities of magnesium bicarbonate appear as almost insoluble white incrusta-

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tions. The analysis of such an excess from evaporated pump water in a strawberry field on black adobe is given below:

Chemical analyses of black adobe from Pajaro area, California.

Constituent.	No. 17123, alkali crust.	Constituent.	No. 17123, alkali crust.
Ions:	*Per cent.*	Conventional combinations:	*Per cent.*
Calcium (Ca)	7.23	Calcium sulphate ($CaSO_4$)	24.57
Magnesium (Mg)	6.88	Magnesium sulphate ($MgSO_4$)	7.11
Sodium (Na)	22.54	Magnesium chloride ($MgCl_2$)	21.35
Potassium (K)	3.08	Potassium chloride (KCl)	5.98
Sulphuric acid (SO_4)	23.01	Sodium chloride (NaCl)	33.60
Chlorine (Cl)	31.92	Sodium bicarbonate ($NaHCO_3$)	7.35
Bicarbonic acid (HCO_3)	5.34	Per cent soluble	.84

This analysis shows the accumulation to consist mainly (over 60 per cent) of the chlorides of sodium, magnesium, and potassium, with the remainder largely made up of gypsum and Epsom salts. Sodium chloride, or common salt, is the most injurious.

Flooding, which would drive away the salts, is never practiced except on alfalfa fields, in which no salts ever accumulate. Berries of all sorts are always irrigated by furrows placed 30 inches apart for strawberries and 4 feet apart for bushberries. In order to rid the heavy soils of these excess salts accumulated by summer irrigation, better and more rapid underground drainage during the winter or rainy season should be provided, either by open ditches or tile drains.

DRAINAGE.

The drainage of the Pajaro Valley is, with a few exceptions, very good. The only swamps in the area are found in the tidal flats along Elkhorn Slough and near the mouth of Larkin Creek. Larkin Creek, having been dammed back by the deposits of sediment placed across its mouth by the Pajaro River, formed a swamp along its course and its branches west of Watsonville on the lower edge of the rolling hill country. The farmers, tempted by the areas of Peat found there, cleaned out Larkin Creek and its branches, and by the addition of drainage ditches entirely reclaimed these swamps at a low cost.

College Lake, the largest of the low lakes north of Watsonville, covers nearly 400 acres and is very shallow, being nearly filled with a rich deposit of soil and muck. If drained, this would be excellent soil for potatoes, onions, celery, and many other vegetables. This lake is no longer used as a source of water for irrigation. A short, deep canal less than half a mile long would entirely drain this lake into Salsipuedes Creek.

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Another area at times becoming too wet is the Pajaro clay loam adobe next the hills on both sides of the Pajaro River. The sediments laid down by the river built up its channel and banks faster than the land farther back toward the hills. Above and within these lower and heavier soils considerable water accumulates, especially in wet winters. During the last two very wet winters many apple orchards there have suffered and some trees have died. This has occurred only upon the heavy-textured Watsonville clay loam adobe. Great improvement could be made in these soils west of Pajaro, north of Watsonville, and south of Aromas, by constructing deep open ditches, which would rapidly carry off the excess water of the winter rains. At all these points the natural fall is sufficient. Swales or channels indicate the best course for the ditches. In addition, drain tile should be used to drain more rapidly the water underneath the soil. On such high-priced productive lands this tile drainage would certainly pay well.

The Watsonville series of soils, consisting of the heavy sandy loam, loam, and clay loam adobe, with clay subsoils, would all be benefited by tile drainage in certain portions devoted to apple orchards, especially so where the impervious clayey subsoil is close to the surface. In such soils, when tile drained, the trees would root better and moisture would be better conserved during the dry season. The result would be a more vigorous growth of trees and fruit of larger size.

SUMMARY.

The soils of the Pajaro Valley may be divided naturally into three series or groups: First, the alluvial Pajaro soils, lying along the river and creek bottoms; second, the residual plains soils of the Watsonville series; and, third, the residual mountain soils of the Santa Cruz series.

The Pajaro soils are by far the most productive and valuable and on them are found the larger portion of the apple orchards, nearly all the berries, and all of the potatoes and sugar beets grown in the valley. They therefore form the main agricultural dependence of the area. These soils differ widely from any others yet encountered in the soil surveys of the State. They are uniformly rich and productive. The price of these alluvial lands ranges from $600 to $1,200 an acre.

The Watsonville soils occupy the low, rolling hills of the valley. Apple orchards are common on these soils, but are less productive than those in the Pajaro series. Grain is extensively grown for hay. The American varieties of grapes do well. Apricots thrive on the sandy loam and pears on the loam and adobe. The price of these lands varies from $60 to $250 an acre, according to improvements and location.

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The Santa Cruz soils, occupying the steep hills and mountains, are best suited for vineyards and orchards of apples and apricots. In their virgin state these soils are covered with trees and brush. They range in price from $15 to $60 an acre.

Other soils are the Peat in the Larkin Valley, two colluvial loams in the Corralitos and Salsipuedes regions, two residual sandy loams in the Monterey Hills, Dunesand on the coast, and the tidal clay soil. Of these only the first three mentioned are of much agricultural value.

The main product of the valley is the apple. This crop mainly supports 10,000 or more people in the valley. The apple orchards cover 15,000 acres, and this is the largest apple-shipping area west of the Rocky Mountains. The output in 1907 was 2,500 cars of apples, and when all the trees are of bearing age the crop should be double this.

The berry crops, which include the strawberry, loganberry, raspberry, and blackberry, are exceedingly profitable, but will become more restricted in area as the orchards are extended. This tendency will be partially overcome by planting berries on the upland or Watsonville series of soils. At present the berry industry employs many persons and the gross returns vary from $600 to $1,000 per acre.

Apricots are a profitable and sure crop on the slopes of the Santa Cruz Mountains and on portions of the Watsonville soils. Pears should be more extensively planted, especially on the Watsonville soils, for canning purposes. Grapes of the European varieties thrive best on the Santa Cruz soils, while the American varieties do best on the Watsonville series. Sugar beets, beans, grain, and potatoes are grown mainly on the Pajaro alluvial soils.

Transportation is afforded by the Southern Pacific Railroad, 30 passenger trains passing daily through the valley. Refrigerated fruit cars are dispatched on fast schedules to far eastern points.

The climate of the Pajaro Valley is one of its greatest assets. There is little variation between summer and winter temperatures, the mean for summer being 65° and for winter 55°, with an annual mean of 60° F. The greatest difference in the two seasons lies in the prevalence of fog in the summer months and of rain in the winter months. However, there is a large proportion of sunshiny days the year round. This cool summer climate attracts many home seekers and hundreds of tourists from the interior of the State and elsewhere.

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SOIL SURVEY OF THE KLAMATH RECLAMATION PROJECT, OREGON.

By A. T. SWEET and I. G. McBETH.

DESCRIPTION OF THE AREA.

The following report covers the soil survey of the territory embraced in the Klamath reclamation project of the United States Reclamation Service, together with certain areas of tillable land which lie adjacent to the project but above the irrigation ditches.

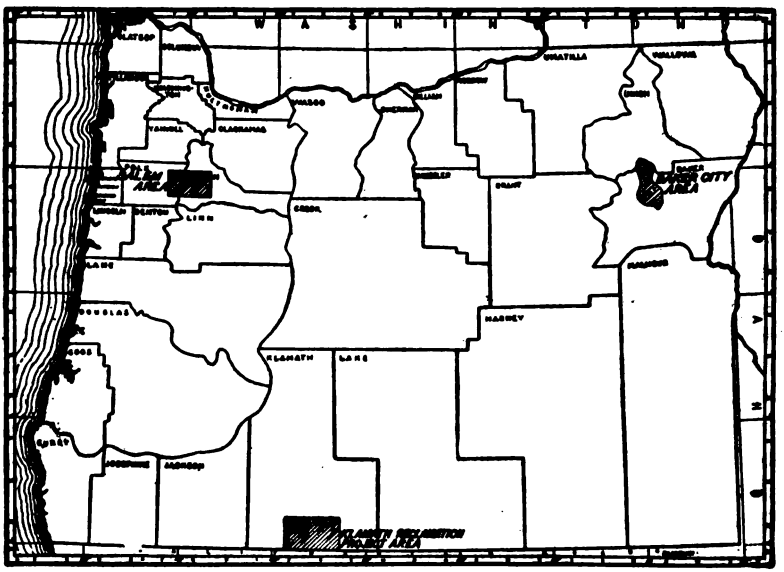

FIG. 38.—Sketch map showing location of the Klamath Reclamation Project area, Oregon.

This area lies between the meridians of 121° and 122° west longitude, and parallel 42° north latitude—the boundary line between California and Oregon—crosses the area near its southern part.

The Klamath country is a basin having an altitude of over 4,100 feet, surrounded on all sides by mountains of greater elevation.

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On the west and southwest is the Cascade Range, two prominent peaks of which, Mount Pitt to the west and Mount Shasta to the southwest, their summits capped with perpetual snow, rise to elevations of 9,760 and 14,440 feet, respectively. Between these peaks there stretches a wide range of mountainous region with many summits reaching an elevation of almost 10,000 feet. These ranges are heavily timbered and covered with snow during the winter season. On the north and east are other mountains of less elevation, eastern outliers of the Cascade Range, with timbered crests and slopes interspersed with occasional outcrops of rock, while to the south and southeast are the famous lava beds of northern California, from which rise numerous barren hills and mountains.

Extending through the area and dividing it into several distinct valleys are other mountains and hills of less elevation. These are also timbered to a considerable extent, forests of pine occupying the higher portions, while on the slopes are scattering junipers, with sage, wild plum, and other shrubs. In many places on the steeper slopes fragments of rock have crumbled from the outcrops above and stretch in broad, barren, dark-colored strips for long distances down the slopes.

These hills and mountains, which occur as elongated ridges, have a general northwest and southeast trend and divide the area into five rather distinct valleys, in some of which minor hills occur.

The most important of the valleys into which the area is divided is the Klamath or "Main Valley," as it is called, stretching from Klamath Falls in a southeasterly direction to Tule Lake, a distance of about 25 miles. Klamath Valley has an average width of about 4 miles, contains approximately 64,000 acres, and includes the principal older irrigated sections of the area. Extending west from near the central part of Klamath Valley and really a part of it is a higher valley known as "Spring Lake Valley," embracing about 9,000 acres of tillable land.

Southwest of Klamath Valley and separated from it by a high barren ridge and by Spring Lake Valley is the basin of Lower Klamath Lake, in which the marsh or tule lands occur. This basin has an area of about 130 square miles or 85,000 acres.

Extending east from the southern end of Klamath Valley there is, along the northern shore of Tule Lake and including a small valley known as "Sand Hollow," a strip of agricultural land of about 10,000 acres in extent. South of this strip it is planned to reclaim an area of about equal extent from the bed of Tule Lake.

East of the northern part of Klamath Valley, but separated from it by rather high hills, is a small triangular basin known as "Poe Valley," containing approximately 9,000 acres. At Olene, near the north-

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west corner of this valley, Lost River passes through a low gap from Poe Valley to Klamath Valley.

Stretching northeast and then southeast along Lost River is a narrow valley the upper and broader part of which is known as "Langell Valley." This valley is about 16 miles long, is from 2 to 3½ miles wide, and contains about 25,000 acres.

Northeast from Poe Valley and extending north from the narrow valley of Lost River is another small farming area known as "Yonna Valley." It is about 9 miles long, averages from 1 to 2 miles in width, and contains about 9,000 acres.

In the entire area surveyed there is a land area of 159,360 acres. Some portions of this are not suitable for farming purposes and other parts can not be brought under irrigation. It is estimated, however, that the total area of tillable land, including that which is to be reclaimed, will be between 150,000 and 180,000 acres.

The Klamath country, so called from the Indian word meaning "the assembled" or "the tribes," is a region abounding in numerous and beautiful lakes.

Lower Klamath Lake lies in the western and southwestern portion of the Klamath Basin and is surrounded by high hills and mountains. These mountains end abruptly at the swamp or lake shore, except in the northeastern part, where the basin opens into Klamath Valley. From Klamath Falls, situated on the narrow stretch of land lying between the upper and lower Klamath Lakes, to Laird, at the extreme southern end the length of the valley, is about 25 miles and the average width about 5 miles, except for 8 miles between Klamath Falls and Miller Island, where the width is about 1½ miles.

This area (approximately 85,000 acres) is known as "Lower Klamath Lake," but there exists in it about 55,000 acres of swamp land which is not covered with water during dry seasons or times of low water in the lake. This land is covered with tall tules, with an admixture of cattails, flags, mint, sawgrass, and yellow pond lilies. At times of low water much of this land is used for pasturage for cattle and horses and for the production of tule hay.

The open water, consisting approximately of 30,000 acres, is divided into several lakes approximately as follows: Lower Klamath Lake (proper), 26,000 acres; Miller Lake, 3,400 acres; White Lake, 800 acres; and Ewauna Lake, 320 acres. Lake Ewauna, the deepest, and lying nearest Klamath Falls, has a depth of about 15 feet, being a widening of the Klamath River. Miller Lake lies in the middle western part and is separated from the tule or swamp land by a high sandy reef 3½ miles in length. This lake is very shallow and alkaline. White Lake is quite similar to Miller Lake, being isolated from the

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main body of water by tule swamps and low ridges of tufaceous material which almost inclose it. Its waters are similar to those of Lower Klamath Lake and are quite shallow, but connect naturally with Lower Klamath Lake through the tule swamps. An artificial connection, called "Adams Cut," has been made, connecting it with Klamath Lake and the Merrill country, which has until recently derived its irrigation from this source. The open water of Lower Klamath Lake lies in the center of this area, occupying the lowest portion. It approaches the hills at only one place at its southern end, where it is much deeper than elsewhere. The water in this lake is quite shallow, but a deep deposit of floating sludge and black muck lies below it. This sludge is often piled in spots by the movements of wind and water, obstructing navigation. The principal source of water for this group of lakes is Upper Klamath Lake, through Link River. The outlet is Klamath River, which flows through the upper part of the basin, then turns west through a narrow pass in the mountains near Keno. At the entrance to this pass a basaltic obstruction has prevented the lowering of the river bed, and resulted in this chain of lakes and wide area of marshy land. A wide channel several miles in length passes southward from the river, supplying the lower lakes and swamps. During seasons of heavy rainfall or during the long dry summers, the Klamath River flows southward through these straits, but at certain seasons when the river begins to fall this channel carries considerable water northward from the lower lakes into the Klamath River, thus presenting the anomaly of a river flowing in one direction during a portion of the year and in the opposite direction at other times.

East from Lower Klamath Lake and separated from it by a mountain barrier 1,000 feet high and less than 2 miles in width is another large body of water covering about 150 square miles and known as "Tule Lake." Only a few small areas along the margin of this lake are at present covered by tules.

In addition to these larger lakes there are within the area proper Nuss Lake, Alkali Lake, Dry Lake, and numerous other small but unnamed lakes, while in the vicinity of the area, but outside of it, are Upper Klamath Lake, Clear Lake, Swan Lake, Round Lake, Long Lake, and many others.

The Klamath area has a peculiar and interesting natural drainage system. The drainage of the western part of the area has already been described. The remainder and larger portion of the area, including Klamath, Poe, Langell, and Yonna valleys, is drained by Lost River and its tributaries. This stream, which has its source in Clear Lake, flows northwest, west, and then southeast, a total distance

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of over 60 miles, emptying into Tule Lake, the waters of which extend to within 6 miles of the source of the river. In Langell Valley this stream flows for several miles under ground, coming to the surface in the vicinity of Bonanza as large springs. It has several tributaries, the most important of which are Miller Creek, which enters Langell Valley from the east, Buck Creek, which drains Yonna Valley, and Lost River Slough, which crosses the northern part of Klamath Valley. This last-named stream extends from near Klamath River to Lost River, apparently occupying the former course of a large stream. In addition to these streams there are many smaller ones, which carry the waters of the rainy seasons into Lost River or into the lakes.

In this area there are also many small, basinlike depressions, with no outlet, which collect the run-off of the rainy season, forming small, shallow lakes which dry up during the summer. These are most numerous in Spring Lake Valley, but occur throughout the area.

The first permanent settler, Wendoless Nuss, came to the Klamath country in 1866 and others soon followed. The object of these earlier settlers was stock raising rather than farming. In 1867 Linkville, the name of which was later changed to Klamath Falls, was founded, and in 1872 a post-office established, the mail being carried from Ashland and delivered once a week. In 1875 a stage line making semiweekly trips was established between Ashland and Linkville. In 1882 Klamath County was formed, the population at that time being only about 700, and settlement continued to be very slow for some time.

In 1884 and 1885 irrigation in a small way was begun, and the value of the country for agriculture began to be recognized. Since that time settlement has been much more rapid. The greatest stimulus to settlement, however, has come during the last three years through the selection of this area as one of the irrigation projects of the United States Reclamation Service, and through the extension of the northeastern branch of the Southern Pacific Railroad to Klamath Falls.

Klamath Falls, situated at the upper end of Lake Ewauna, is the largest town of the area, having a population of between 2,000 and 2,500 people. It is situated on Link River, which may be made to furnish an abundance of power for manufacturing purposes. It is the county seat of Klamath County.

Merrill, situated about 22 miles southeast of Klamath Falls, on Lost River, is near the center of the best developed farming section of the area and has a population of about 300. Bonanza, situated on Lost River 25 miles east of Klamath Falls, has a population somewhat less than that of Merrill. Merrill and Bonanza are both reached by a high-power transmission line, the power being generated by Link

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River. This supplies light and power needed for manufacturing purposes, flour mills in both towns being run by electricity. Keno, situated in the extreme western part of the area, and Dairy, situated 7 miles northwest of Bonanza, are small towns at which considerable business is transacted.

The lack of transportation facilities has in the past greatly retarded the development of the Klamath country. Horses, cattle, and sheep which could be driven to the railroad and shipped to market were the only source of revenue. Until recently stock was driven to Montague or other points on the main line of the railroad, distances of from 75 to more than 100 miles. At the present time, however, a branch of the Southern Pacific system is being extended from Weed, Cal., to Klamath Falls. This line is being rapidly constructed and will no doubt in the near future reach Klamath Falls.

Supplies for Bonanza, Poe, Yonna, and Langell valleys are now hauled principally from Klamath Falls, while those for Merrill and the southern part of the area are hauled from different points on the new line of railroad around the south end of Lower Klamath Lake, Mount Hebron and other points on this line being now used for shipping points for stock from the entire area.

The principal markets for stock as well as the principal points from which supplies are received are Portland and San Francisco, each distant about 350 miles from Klamath Falls.

The stream channels and lakes of the western part of the area are plied by steamers, which carry passengers and freight, and by rafts of logs, aiding very materially in the commerce of the region. Klamath Falls, Teeters Landing, Keno, and Laird are points reached by these streams.

CLIMATE.

The climate of the Klamath area is semiarid in character, the average annual rainfall being about 14 inches. This falls principally during the winter and spring months, the heaviest precipitation occurring in the months of March and April. During the summer season little rainfall occurs, although light showers are not uncommon. During the fall, winter, and early spring snowfall is of frequent occurrence, the snow sometimes remaining on the ground for a considerable time.

Owing to the high elevation and the influence of the higher mountains to the west of it the Klamath area has a low average temperature, but not one of great extremes. During the winter season the temperature rarely falls below zero, and during the hottest weather rarely exceeds a temperature of 95° F. The nights are uniformly cool. The following table compiled from reports of the Weather Bureau

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shows the mean temperature at Klamath Falls for a period of several years and the average monthly temperature for this period:

Mean monthly temperature for Klamath Falls.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1884	29	26	37	42	54	56	61	65	49	44	42	29
1885	34	37	47	53	56	58	72	71	56	51	39	35
1886	31	43	38	47	56	61	64	65	57	47	38	41
1887	39	28	46	47	55	57	66	64	58	50	38	31
1888	20	38	38	51	55	56	64	.....	64	50	38	36
1889	28	36	44	51	54	66	69	65	58	49	.....	.....
1894	.....	.....	42	46	57	57	72	73	.....	.....	.....	.....
1895	.....	.....	.....	.....	54	64	67	67	57	56	44	.....
1897	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	31
1898	26	36	37	.....	.....	62	72	71	60	46	35	29
1899	33	33	39	46	49	62	70	61	66	.....	.....	.....
1900	39	.....	.....	.....	54	60	.....	.....	.....	45	41	34
1901	25	31	38	44	55	57	68	70	55	52	41	33
1902	30	38	39	45	53	61	63	68	64	47	38	33
1903	32	27	37	46	.....	63	65	.....	.....	.....	.....	34
1904	27	31	35	47	58	59	.....	.....	.....	50	45	33
1905	36	36	43	48	47	.....	.....	.....	.....	.....	.....	.....
1906	28	32	35	48	55	59	75	69	51	.....	.....	.....
1907	.....	42	35	48	54	58	68	52	56	58	39	35
1908	33	35	38	49	.....	55	.....	65	.....	.....	.....	.....
Average for period	31	34	39	47	54	59	67	69	58	49	39	33

From this table it will be noted that December, January, and February are the three coldest months, but that the mean temperature for this period is not low, while July and August, which are the hottest months, show a comparatively low summer temperature.

The growing season does not begin until late in the spring and is often cut short by early frosts in the fall. No record is obtainable of the dates on which killing frosts have occurred, but that their occurrence is a serious menace to the successful growing of fruits and vegetables easily injured is a fact recognized by all who are familiar with the conditions. When the growing season has once begun, however, the clear air, warm sunshine, and fertile soil produce almost phenomenal results in a comparatively short time.

AGRICULTURE.

Agriculture in the Klamath Basin is comparatively undeveloped. Some ranches have been under cultivation for twenty years or more, but most of them have been cleared much more recently, and each year there is an extension of the farming area. At the present rapid rate of settlement, within a very few years all available farming land,

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including not only that which can be irrigated but also the dry farming area, will be brought under cultivation.

The present state of agriculture has been reached by very gradual stages. As has already been noted, the early settlers were engaged almost exclusively in stock raising and the nearest approach to farming was the cutting of wild hay for winter feed. During the summer stock was grazed among the mountains and lava beds and in winter brought into the lower and better protected valleys, where they fed on the grass of the marshes. During some entire winters they would find an abundance of feed, but during others heavy and continued snowfall would make the feeding of hay necessary. At such times an insufficient supply of hay often resulted in heavy loss from starvation.

In time the settlers began to sow rye and cut it for hay, and at the present time, outside of the irrigated section, rye constitutes the principal hay supply. The ease with which rye could be grown in time led to the growing of other grain crops and the production of grain by very simple and inexpensive dry farming methods, which have continued in use to the present time. The sagebrush is cleared off and the loose soil plowed to a depth of a few inches, after which the grain is drilled or sown broadcast and harrowed in. Summer fallowing has not yet come into use in this area, the soil being rich and productive and the rainfall usually sufficient to produce a fair crop.

In some cases the soil is prepared for the second crop of grain by a thorough harrowing, which leaves the surface in fair condition and has the advantage of leaving the stubble of the preceding crop on the ground, thus preventing to a considerable extent the drifting of the sandy soils.

Grain crops are also grown in the irrigated sections of the area and not only give much larger yields but are also much more certain than are the nonirrigated crops. On the better soils under favorable conditions irrigated wheat and barley each give a yield of from 30 to 40 bushels per acre and oats from 60 to 75 bushels per acre, the grain being of excellent quality. When dry-farmed the yields under favorable conditions of soil and weather are about half of those stated.

When irrigation was begun in a small way the water was used principally on pasture land, but in time alfalfa was introduced and at present is the principal irrigated crop of the area. It yields two good crops a year, with occasionally a smaller third crop, but is usually pastured after the second cutting. The average yield of alfalfa for the entire irrigated section the past year was almost 3 tons per acre for the two cuttings, while many fields yielded 4 tons with two cuttings and a few as high as 5 tons. Alfalfa is also grown without irrigation in certain restricted areas. Part of this is grown where no

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ground water can be reached within several feet of the surface, the crop being entirely dependent upon the moisture conserved in the soil from rainfall. Some is also grown without irrigation where ground water is reached at depths varying from 3 to 6 feet. In the first case only a thin stand can be maintained and the growth is not large, one small cutting usually being obtained. Where ground water is nearer the surface the yield under favorable conditions is fairly satisfactory, but owing to the tendency of the ground water to fluctuate and in this way injure the roots such alfalfa usually dies out within a few years.

In this area the opinion seems to be prevalent that alfalfa needs no fertilization, but even on fertile and almost virgin soil, such as that found in the Klamath Basin, when irrigated it responds readily to a liberal use of well-rotted manure.

By giving more attention to the preparation of the seed bed so that a good stand may be secured, by using greater care in leveling the fields so that some spots will not die from lack of water while others are drowned from an oversupply of it, and by using all available manure on the alfalfa fields, the yields may be very materially increased.

In the irrigated sections alfalfa constitutes the principal feed for work animals during the entire season. It is also used to some extent for dairy cows, but the principal part of it is used for feeding stock which is brought into the valley from the ranges in the fall. The price of alfalfa in the stack during 1908 ranged from $7 to $8 a ton.

Timothy, usually mixed with alfalfa, is grown to a very limited extent and gives a yield of 1½ to 2½ tons per acre. This hay is of excellent quality.

The growing of potatoes has received considerable attention, and both soil and climate seem well suited to this crop, except for occasional erratic frosts. Potatoes are grown principally on the slopes above the floor of the valley, such slopes being freer from frosts than the lower lying areas. They are grown largely without irrigation, the areas devoted to them being principally above the irrigation ditches. The soil receives a shallow plowing in the spring, the potatoes are planted, and often receive little cultivation, but a yield of from 50 to 100 bushels to the acre is not uncommon. When irrigated much larger yields are obtained.

In the small valley of Link River and on some of the sheltered slopes in and near Kalamath Falls gardening is receiving some attention. Garden truck of excellent quality is grown, but on account of the shortness of the growing season the crops are somewhat uncertain, since only those not easily injured by frosts can be depended upon.

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The price of land in the area varies greatly, depending upon the kind of soil, location, and improvements. The price of the better grades of land unimproved and usually covered with a heavy growth of sagebrush ranges from $20 to $50 an acre, while improved land of the same character is held at $50 to $75 an acre and in some cases at $100 an acre. This does not include the cost of water which will be furnished by the Reclamation Service, this charge depending upon the cost of constructing the irrigation system. It is not yet known what the cost will be, but when determined it will be paid by the owners of the land in ten annual payments, after which the system will become the property of the landowners and the cost of water will be the amount necessary to pay the maintenance and operating expenses of the system.

In 1900 the average size of the farms in Klamath County was nearly 500 acres. One of the conditions, however, under which the Reclamation Service has agreed to furnish water for irrigation is that no holding receiving water shall contain more than 160 acres. Where farms contain more than this amount the excess must be sold or turned over to the Government for sale.

With the completion of the railroad to Klamath Falls this area will be in direct communication with San Francisco and Portland, and it will no longer be necessary to limit the products of the country to live stock and those crops which can be consumed at home. The railroad will not only make these and other markets accessible, but will make it practicable to exploit the timber resources of the region. This development will mean an increased demand for farm products which the people of the Klamath Basin will be in a position to supply.

Of the staples which this area seems best suited to produce dairy products are among the most important. With its cool summers and not severe winters, its fair yields of excellent alfalfa, and its abundant water supply it should be an excellent dairy country.

At present a small creamery is in operation at Bonanza, receiving barely enough cream to pay for running, and another was operated for a while at Merrill, but closed for lack of patronage. This want of interest seems to be due largely to insufficient knowledge of the requirements of the business and to scarcity of good dairy cows.

At the present price of butter fat a high-grade dairy cow, properly fed and cared for, should yield a gross income of from $60 to $100 a year. On the better grade of alfalfa land in the Klamath area 20 cows can be kept throughout the year on from 40 to 60 acres, and including the returns from calves and separated milk fed to hogs should yield a net income of not less than $1,000 a year. It is doubtful, however, if at present general farming or dairying should be attempted on a farm of much less than 80 acres.

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The raising of hogs on alfalfa may be made a very profitable business, but so far has received little attention in this area. If young hogs are placed on alfalfa as soon as it is well started in the spring they will make an excellent growth throughout the summer and fall, and after being fed for a few weeks on crushed barley, wheat, or field peas are ready for market.

On account of the wide area of open range adjacent to the Klamath project the raising of large numbers of horses, cattle, and sheep and the supplying of winter feed for them will always be an important business. The country and climate seem especially suited to the development of good horses.

Several crops which might become profitable are receiving little or no attention. Timothy is grown successfully in only limited areas of the West, yet timothy hay of good quality commands a high price on the market. With the opening of transportation facilities it would seem that timothy or timothy mixed with alfalfa or clover could be made a profitable crop for shipment.

The growing of Canadian field peas seems to have received little attention in this area, although both soil and climate are well suited to their production. This crop may be cut for hay or when the peas have begun to ripen may be used as pasture for hogs or sheep. When so used they make one of the best fattening crops.

The saving of alfalfa seed, where alfalfa will mature seed in paying quantities, is a profitable business, yet one which seems to have been entirely overlooked in this area. During the months of July and August, wherever conditions have been favorable for the ripening of alfalfa seed, as along the ditch banks or in fields which have a poor stand and have received only a little water, the alfalfa plants are found to be loaded with seed of the finest quality. If it is desired to produce seed a field having a very thin stand should be selected and in this area the first crop should be used. If necessary the crop may be irrigated early in the season, but after the blossoms begin to form no more water should be applied and the soil should be allowed to become fairly dry. When the seed pods have begun to turn brown the alfalfa should be cut.

The cost of thrashing and cleaning alfalfa seed is usually $1 a bushel and the yield of a good crop should be from 2 to 5 bushels per acre. Alfalfa seed is selling now (1908) at prices ranging from $8 to $11 a bushel wholesale.

Among the crops best suited to the Peat are barley, oats, timothy, redtop, alsike clover, and red clover. Cabbage, turnips, lettuce, celery, and onions should give good yields. Potatoes should also yield well, although the danger from frost may be somewhat greater than on the uplands.

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The chief value of the Peat will be the production of root, forage, grain, and hay crops for the feeding of cattle, sheep, hogs, and horses. Dairying and the production of animals for the block will always be a leading industry, to which the conditions are eminently adapted.

From the character of the soils in the Klamath area and their similarity, both in origin and texture, to the soils of other regions in which fruit growing has become an important industry, the conclusion has been reached that this area is also well suited for fruit growing. If the soil alone were to be considered this probably would be true, but unfortunately the climate of the Klamath area, with its killing frosts late in the spring and early in the fall, is such that fruit growing on a commercial basis will always be a rather uncertain business. Proof of this is to be found in the weather records of the area and in the yields obtained in the few small orchards old enough to bear, the results seeming to show that only about two good crops in five years may be expected, with very small or no crops in the intervening years. It is believed, however, that by selecting the best sheltered portions of the basin, by introducing hardy varieties, such apples as the Spitzenburg, Banana, Jonathan, and Bellflower, for instance, and by protecting the orchards with closely planted wind-breaks, much more fruit may be grown than at present, and no ranch should be without a small, well-protected orchard, even though the crop is uncertain. It is even possible that by the use of all available means for protection, orchards on a large scale, through the yielding of large crops of good fruit at intervals, might be made profitable, but such experiments should not be undertaken by new settlers, who, more than anyone else, need crops which can be depended upon.

Cherries, plums, blackberries, raspberries, gooseberries, and currants grow well and give large yields, while in the mountains northwest of the area there are hundreds of acres of wild huckleberries, from which large quantities are gathered each year. Wild plums are also common in this region.

In different parts of the area experiments have been carried on in a small way with sugar beets, and a large tonnage of beets having a high sugar content produced. The soils of a considerable proportion of the area, especially in the vicinity of Merrill and along the north shore of Tule Lake, are well suited in character and in slope of land for this crop. The successful growing of sugar beets, however, requires an intensive type of farming for which the people of this area do not yet seem to be prepared.

Better farming methods are needed throughout the area. Although good crops are now produced, better preparation of the soil and more careful seeding will more than repay for the extra labor.

Already weed pests are getting such a foothold that they can be eradicated only with great difficulty. One of the worst of these pests

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is the "death" or "poverty" weed (*Iva axillaris*), common throughout the alkali and poorly drained sections. This plant alone the past year caused losses in grain and alfalfa fields amounting to many thousands of dollars. Foxtail (*Alopecurus*) is another weed which grows in wet, poorly drained areas and is especially troublesome in alfalfa fields.

The Russian thistle, one of the worst weed pests with which the western farmer has to deal, has already made its appearance in a few places in the area, and unless vigorous means are taken to eradicate it, will undoubtedly cause great loss to the farmer in the near future.

SOILS.

The soils of the Klamath area are derived principally from three sources: First, from the "chalk" which underlies a large part of the basin; second, from the disintegration of the basaltic rocks of which the adjacent hills are composed; and, third, from the decay of organic matter.

Extending under the basin is a light-colored material locally referred to as "chalk," "chalk rock," or "hardpan." When dry it varies in color from almost white to a light yellow or buff, but when wet and mixed with a small quantity of other mineral matter or decayed organic matter it becomes much darker, often being dark gray or almost black in color. In places it is clearly stratified, the different thin layers being shown by differences in color, but in other places it has a massive structure. When dry it is so light that it floats on water, and the soil formed from it is very fine and light in weight, resembling flour more than soil. It varies considerably in composition, the field examinations showing variation in color, weight, and texture. Tests with hydrochloric acid in places gave a rapid effervescence, thus indicating the presence of considerable quantities of carbonate of lime, while in many other places the application of acid produced no effervescence. A complete analysis of a sample taken from the ditch bank southeast of Klamath Falls shows it to contain a high percentage of silicate and a very low percentage of potash and phosphoric acid. Examination of this material from different parts of the area by means of the electrolytic bridge showed considerable variation in the soluble salt content, but as a whole it carries a much higher percentage of such salt than is carried by the sands or sandy loams. An examination of this "chalk" under the microscope shows it to contain minute shells, the remains of diatoms which probably lived in fresh lake waters. The diatoms are of many different varieties. Samples from different parts of the basin vary in the proportion of diatomaceous

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material from only a few scattering fragments in some samples to masses made up almost entirely of diatoms in others.

This material, which will be referred to in this report as "chalk," because so known locally, was deposited in earlier times in a lake which covered the entire basin and was probably formed through the damming of the Klamath River by a recent lava flow.[a] While it varies considerably in composition as a whole, the "chalk" is made up largely of volcanic ash which was carried by winds and waters and deposited in this shallow lake together with the diatomaceous earth, and is composed largely of siliceous or glassy material, resulting in this case in an unproductive soil.

Throughout the larger part of the area this "chalk" occurs as subsoil, the upper portion of it being mixed with the overlying or weathered soil, which varies greatly in thickness. In a few places, however, the chalk has no surface covering and is washed down into the lower portion of the valleys, where it is mixed with the soils or forms the surface material. The following table shows the relative amount of diatomaceous material in this formation:

Microscopical examination for diatomaceous material.

Number of sample.	Location.	Relative amount.
19285	SW. ¼ sec. 17, T. 48 N., R. 2 E	Medium.
19293	One-fourth mile S. cen. sec. 28, T. 48 N., R. 2 E	Do.
19294	Subsoil of 19293	Do.
19295	.....do	Large.
19296	.....do	Do.
19297	Three-eighths mile E. cen. sec. 29, T. 48 N., R. 3 E	Medium.
19298	Subsoil of 19297	Do.
19299	.....do	Small.
19307	One-half mile SW. cen. sec. 28, T. 40 S., R. 8 E	Do.
19308	Subsoil of 19307	Medium.
19309	.....do	Do.
19312	SW. cor. sec. 16, T. 47 N., R. 3 E	Large.
19317	SW. ¼ sec. 24, T. 39 S., R. 8 E	Medium.
19319	One-fourth mile SW. cen. sec. 4, T. 41 S., R. 9 E	Large.

The hills and mountains surrounding and extending through the Klamath area are volcanic in origin and, excepting the "chalk" found at their base and in places extending under the volcanic rocks, are formed of basalt of different kinds. Much of this basalt is very hard and its transformation into soil would seem a very difficult matter, but under the agencies of weathering it breaks down rather rapidly, forming the soils not only on the slopes of the hills, but also over much of the basin.

[a] Diller, Geology and Petrography of Crater Lake National Park, page 7.

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The soils upon the south and southwest slopes which receive the most sunshine and the greater part of the rainfall are light and sandy, while on the north and northeast slopes, where the changes of temperature are less frequent and less marked and where the soil during the winter season often remains moist for long periods, the tendency is toward heavier soils. This difference in texture is caused in other ways, as by the action of seepage water or water from springs upon the soil, thus breaking the coarse particles down into finer ones, often by this means forming an adobe from a sandy soil. Hot springs are especially efficient in rock decomposition, thus hastening the formation of heavy soils. This is quite noticeable in the vicinity of Klamath Falls and on the west side of Langell Valley, where north-slope seepage water and hot springs have in places combined to form areas of adobe.

The overflow lands along streams, especially if kept moist for a considerable period, also become heavier through the action of the water on the soil grains. The heavy soils along Lost River and those in the bottoms of the numerous shallow basins in the area have been formed in part by this means.

These basalt soils, except in very limited areas, are not found resting upon the rocks from which they were formed, but as they are loosened by frost and heat are gradually carried down the slopes by gravity and by the rain and wind.

Soils which remain in place, covering the rocks from which they have been formed, are known as residual soils, those which have gradually moved down the slopes as colluvial, those which have been suspended in streams and redeposited as alluvial, and those which have been carried by the wind as eolian. Representatives of all four of these divisions are to be found among the soils of basaltic origin in this area.

In addition to the soils composed largely of "chalk" and those of basaltic origin, there is a third class of soils quite different from either. In certain parts of the area conditions have been and are still very favorable for the rapid growth of tules, marsh grass, and like plants, and these have grown so luxuriantly that at present the soil contains a very high percentage of organic matter from their decay. Locally these areas are known as marsh soils. They are confined principally to the basin occupied by Lower Klamath Lake, while the soils of the other two classes are mingled almost indiscriminately throughout the remainder of the area.

The soils of the area are with but few exceptions light and friable, easily cultivated, and not difficult to handle when irrigated, and their value for the particular crops suited to this section depends very largely upon the depth of soil, freedom from alkali, and thorough drainage.

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On account of similarity in origin and arrangement the principal upland soils of this area have been correlated with the soils of the Yakima series, while the remaining soils, consisting of the marsh soils and those which have been modified by the addition of organic matter and by being reworked and deposited on flood plains and in basins, have been placed in a new series to be known as the Klamath soils.

The following table gives the name and extent of each of the soil types found in the Klamath reclamation project area:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Yakima sandy loam	70,464	44.2	Yakima loam	6,912	4.3
Yakima sand	25,600	16.1	Klamath fine sandy loam	2,048	1.3
Yakima fine sandy loam	17,280	10.8	Yakima clay adobe	384	.3
Yakima clay loam	15,680	9.8	Peat	384	.3
Klamath loam	11,776	7.4	Total	159,360	.....
Klamath clay adobe	8,832	5.5			

YAKIMA SERIES.

The members of the Yakima series are probably residual soils derived mainly from basaltic rocks in place, or they may be in part sedimentary from the same material reworked and deposited in ancient lakes. The series occurs in the intermountain region, and has been mapped already in Oregon, Idaho, Montana, and Washington. In many places volcanic ash forms an important constituent of these soils. In the present area the diatomaceous earth has contributed to their formation.

YAKIMA SANDY LOAM.

The Yakima sandy loam is typically a light-brown, yellowish-brown or reddish-brown sandy loam, the color becoming much darker when the soil is moist. In certain limited areas the color is gray and in others, where the content of organic matter is large, it is very dark brown or black.

The lower portion of the soil and the subsoil is light brown or yellowish brown or gray in color, while the lower subsoil is a light-yellow or buff color when moist, often almost white when dry.

In texture this soil is a medium to fine sandy loam in which the sand grains are neither waterworn nor very sharp, but are roughly angular, giving the soil a harsh, rough feel when rubbed in the hands. The surface soil is usually light, the surface 3 or 4 inches in many parts of the area being a sand, but the surface soil grades into a slightly heavier sandy loam which extends to a depth of from 15 inches to 3 feet or more, the average depth for the entire area probably being about 30 inches. The lower subsoil or "chalk" carries a

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rather high percentage of silt and clay, being in texture a clay loam or sometimes a silt loam.

Limited areas of this soil with sand-covered surface occur in the vicinity of Manning Ridge, in portions of Sand Hollow, and in many other parts of the area. There are other sections of the area in which the sandy loam has a surface covering of silty material resembling pumice which extends to a depth of 2 or 3 inches. The best example of this is to be found southeast of Miller Hill. In other parts of the area the sandy loam becomes quite heavy, approaching a heavy fine sandy loam or light loam in texture. These heavier places often occur where some small intermittent stream enters the valley, carrying silt and clay, also making the soil heavier by their admixture. Examples of such areas caused by small streams are to be found east of the Carr Ranch, on the south side of Poe Valley, and in many other parts of the area. This heavier soil also occurs in places on the hill slopes away from the influence of intermittent streams, an example of which is seen in sec. 2, T. 39 S., R. 9 E., 2½ miles southeast of Klamath Falls. In limited areas the Yakima sandy loam contains considerable coarse sand, an example of this variation being noted along the east side of Tule Lake north of Bloody Point. It also shows considerable variation in the vertical section, the surface material often being quite fine but underlain by soil of coarse texture, while the reverse is sometimes true. It is in the depth of soil and character of the subsoil, however, that the greatest variations occur. On the upper portions of some of the slopes and at the point of the hills it often contains numerous rock fragments sufficiently large to interfere with cultivation, the soil being shallow and resting on the basalt from which it has been formed. In these higher places small areas of comparatively good soil often occur interspersed with rock-covered areas which can not be cultivated. A considerable area of soil of this character occurs on the east side of Langell Valley. On the lower slopes of some of the hills the light sandy loam has been found extending to a depth of 4½ feet, although it is not usually so deep. In the lower portions of the valleys the sandy loam is in places not over 15 inches in depth, these shallower areas usually occurring in or near the low, poorly drained areas, although in most places it has a greater depth. In parts of the area the subsoil contains thin layers of soft sandstone slightly cemented with carbonate of lime, while in other places at a depth of about 3 feet a conglomerate 4 or 5 inches thick and composed of waterworn gravel and small pebbles rather firmly cemented is encountered. This conglomerate occurs in Spring Lake Valley south of Miller Hill, on the point of the hill northwest of White Lake City, and in other parts of the area.

As a whole the Yakima sandy loam may be said to be the best soil of the area, occupying as it does the gentle hill slopes and the

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better drained portions of the valleys, the deeper and better drained portions being the more desirable. The surface is usually smooth and easily prepared for irrigation. The soil is comparatively free from alkali. In its virgin state the sandy loam is usually covered with a dense growth of black sage, some of this being 3 inches in diameter at the base and having a height of from 3 to 8 feet. Where the soil is shallow the sage is small and scattering. On the higher slopes are juniper, wild currant, gooseberry, plum, and in some places pine.

This soil is well suited for the raising of alfalfa, grain, potatoes, and fruits.

The average results of the mechanical analyses of fine-earth samples of the soil and subsoil of this type are shown in the following table:

Mechanical analyses of Yakima sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18677, 18940, 19180, 19324, 19327.	Soil.....	1.1	8.9	9.5	37.7	14.7	17.5	10.7
18678, 18941, 19181, 19325, 19328.	Subsoil.....	1.4	8.7	8.6	35.5	14.1	19.6	12.1

The following sample contained more than one-half of 1 per cent of calcium carbonate ($CaCO_3$) No. 19181, 3.31 per cent.

YAKIMA SAND.

The Yakima sand is typically a yellowish or reddish-brown medium to fine smooth sand, the subsoil being of about the same texture as the surface soil, but usually lighter in color. In portions of the area, however, the sand is underlain at a depth of about 3 feet by yellowish sticky sandy loam, the upper portion of which is sometimes slightly cemented, forming a thin, soft sandstone or hardpan which breaks down rather easily. In other small and unimportant areas it also contains a rather large proportion of coarse, rough sand.

The surface of the Yakima sand is comparatively smooth, although somewhat more uneven than that of the sandy loam, and when uncultivated is almost uniformly covered by a dense growth of little rabbit brush, the yellowish-green foliage of which is easily recognized. In some portions of the area, however, where the sand is underlain by heavier soil, sagebrush is found growing on the sand. Normally it is free from alkali, but in areas of heavier subsoil and where drainage is deficient, alkali is formed in injurious quantities.

The Yakima sand, like the sandy loam, has been formed principally from the breaking down of the basaltic rocks of the hills, but the sand has been sorted out by the wind and in some cases by water and has been left in its present position.

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The largest areas of this soil occur along Lost River, between the East Branch of the main canal and Stuckel Bridge and in Sand Hollow, but smaller bodies, many of them too small to be shown in the map, are found throughout the area.

The large body of sand along Lost River was probably carried to its present position by the flood waters of that stream when the volume of water was greater than at present, while the large body in Sand Hollow and the smaller bodies in other parts of the area are probably to a considerable extent wind deposits. In a few limited sections this soil is found drifted into small dunes, but drifting has been impeded to a considerable extent by the vegetation which it supports. When broken it drifts rather badly, but when a stand has been obtained it produces good crops of grain and alfalfa, being especially adapted to the growing of the last-named crop. On account of the permanent sod formed by alfalfa this soil should be used for that crop as much as possible. It also gives good yields of potatoes.

The average results of mechanical analyses of the soil and subsoil of this type are shown in the following table:

Mechanical analyses of Yakima sand.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18675, 18934, 19178.	Soil.....	2.7	13.8	12.2	49.0	10.2	6.9	5.0
18676, 18935, 19179.	Subsoil.....	3.3	13.8	11.2	45.3	10.4	8.9	7.4

YAKIMA CLAY LOAM.

The Yakima clay loam is an ashy-gray or almost white silty clay loam. When dry it has a fluffy and flourlike texture. When wet it is quite sticky and in places shows an adobe structure. It is to a considerable extent a residual soil, having been formed from the "chalk" beds, the upper portion of which has been gradually changed into a soil through weathering, the decay of plants, and cultivation, and mixed with sand from adjacent areas. The surface soil from a few inches to about 15 inches usually grades into the "chalk" from which it has been formed. In many places, however, silt and clay from exposed "chalk" beds on the hillsides have been washed down into the valleys and deposited along the small stream courses. In other places the "chalk" from surrounding areas has been washed into the numerous basinlike depressions which occur in some parts of the survey, forming small areas of silty adobe. These are especially noticeable in Spring Lake Valley. In many parts of the area, and especially in Poe Valley, there are low, broad areas separated from

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the adjacent higher level areas by a sort of bench 2 or 3 feet in height, the clay loam occupying the lower areas and sandy loam the higher.

Over the greater proportion of the area this clay loam has a surface covering of from a few inches to as much as 15 inches of sand, sandy loam or fine sandy loam, this being most noticeable near the adjacent areas of sandy soil. In some places this surface covering is in the form of mounds, giving the areas a very uneven surface. A good example of this is seen along the gravel road southeast of Klamath Falls.

Where the clay loam is covered to a depth of from 12 to 15 inches by sandy soil, is well drained, and free from alkali, it is fairly productive, but where the "chalk" forms a considerable portion of the surface soil it is a poor and unproductive type. Where it can be irrigated it may be greatly benefited by a liberal use of manure and by plowing under green crops. When once seeded to alfalfa it produces fairly good crops, but, as a whole, it is less productive than the sand or sandy loam, and usually carries injurious amounts of alkali. It occupies the lower portions of the valleys and is often poorly drained.

This soil is distributed throughout the larger part of the area, and in its natural state supports a growth of large rabbit brush, greasewood, salt grass, and other alkali-resistant plants.

The average results of mechanical analyses of the soil and subsoil of this type are shown in the following table:

Mechanical analyses of Yakima clay loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18679, 18681, 19080.	Soil.....	0.3	3.6	2.5	7.2	8.1	54.0	24.3
18680, 18682, 19081.	Subsoil.....	1.4	5.8	4.4	11.5	9.1	43.8	24.3

The following sample contained more than one-half of 1 per cent of calcium carbonate ($CaCO_3$): No. 19081, 2.86 per cent.

A determination of the organic matter gave the following percentage: No. 18679, 5.75 per cent.

YAKIMA FINE SANDY LOAM.

The Yakima fine sandy loam is a smooth fine sandy loam varying in color from ashy gray to brown or yellowish brown, and is made up almost entirely of fine sand, very fine sand, silt, and clay derived from the breaking down of the basalts of the hills. In method of formation, depth of soil, character of subsoil, and crop value it has rather wide variations, which can best be described as separate phases of the same soil.

On the west slope of Klamath Valley, 1½ miles west of Stukel Bridge and extending a considerable distance to the south, is an

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important body of the Yakima fine sandy loam. It is light brown or yellowish brown in color and extends to a depth of 5 or 6 feet, there being little difference in color or texture between the soil and subsoil. Other smaller bodies of this soil occur on the hill slopes in different parts of the area, but on account of their small size and indefinite boundaries they have been included with the Yakima sandy loam.

Extending west from Adams Cut, southwest of Merrill, is another rather large body of this soil, the lower lying portions of which contain considerable alkali, this being especially true in the part adjacent to White Lake. As this soil extends farther up on the hill slopes it usually becomes shallower and is underlain either by "chalk" or by basalt at depths varying from a few inches to 2 or 3 feet. The hills directly west of Merrill consist of numerous small bodies of this shallow fine sandy loam, underlain by "chalk" or by a soft, porous volcanic rock, interspersed with nonarable, rock-covered areas.

These soils are colluvial and residual in origin, the larger part of them being above the lines of possible irrigation ditches, and are used for dry farming, grain and potatoes being the principal crops.

In their natural condition these soils support a dense growth of sagebrush and in the vicinity of White Lake a growth of greasewood.

Near the center of the Klamath Valley is another phase of the Yakima fine sandy loam, one of the largest bodies of which extends north from Lost River Slough. Another occupies the valley floor 1 mile west of Stukel Bridge. This soil is in most places separated from the soils of the adjacent hill slopes by a rather clearly defined bench or terrace, and is characterized by an almost perfectly flat topography. Where this soil occurs adjacent to Lost River it is usually darker in color and heavier in texture than the typical soil, this condition resulting from more recent deposits along the river. Under these conditions there is no sharp line of demarcation between this soil and the more recently deposited Klamath fine sandy loam.

The material of which this soil is made up differs but slightly from that of the fine sandy loam of the hill slopes, except in having been spread out over a plain. This deposition probably occurred at one stage of the lake which formerly filled the Klamath Basin.

The surface soil is a very light, friable, smooth, fine sandy loam, which extends to a depth of from 15 to 30 inches, where it is underlain by a sandy loam slightly heavier in texture. This reaches to a depth of 6 feet or more, or is in turn underlain by the "chalk." The upper portion of this subsoil is often cemented into a soft, easily disintegrated hardpan, 2 or 3 inches in thickness, which frequently contains considerable quantities of black alkali. The subsoil below the hardpan also contains alkali.

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On account of the high capillary power of this soil and the presence of alkali in the subsoil, the danger from a surface accumulation of alkali in injurious amounts when the soil is irrigated is very great. In its natural condition this phase of the Yakima fine sandy loam supports a scattering growth of large rabbit brush, salt grass, and in some places greasewood. A strip of this soil free from alkali and hardpan extends for a considerable distance along the north edge of Tule Lake. The value of the Yakima fine sandy loam as a whole depends upon the depth of soil, freedom from alkali, and possibility of irrigation and drainage. Where these conditions are favorable it is one of the best soils of the area, well suited to the growing of alfalfa, grain, potatoes, and such fruits and garden truck as may be grown in the area.

The average results of mechanical analyses of the soil and subsoil of this type are shown in the following table:

Mechanical analyses of Yakima fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18938, 19717.....	Soil.....	0.4	5.7	6.4	33.1	20.4	24.8	9.1
18939, 19718.....	Subsoil.....	.7	4.2	4.4	28.1	24.6	26.3	11.6

YAKIMA LOAM.

The Yakima loam consists of a reddish-brown loam containing much fine sand in the surface 3 or 4 inches, below which it becomes heavier in texture. When dry it is friable and has the appearance of being a fine sandy loam, but when wet it is quite sticky. Upon drying after being wet and compacted it breaks with a shaly fracture. At a depth of about 16 inches the surface soil grades into a yellowish sticky loam, also containing much fine sand. This subsoil may extend to a depth of 6 feet or more or may be underlain by basalt fragments or by chalk at a depth of 3 or 4 feet. In places many small sharp rock fragments are scattered over the surface and through the soil. It has also in places been transformed by the action of moisture into a dark-brown or almost black adobe, these adobe areas being too small to be indicated on the soil map.

In many places where this soil approaches the marshes or the lower portions of the valleys it becomes dark in color, heavier in texture, and often contains some alkali, thus resembling, and in places merging into, the loam of the Klamath series. Bodies of this loam occur along the rather steep hill slopes west of the Klamath River in Langell Valley and in other parts of the area. The greater part of this type is well drained, comparatively free from alkali, retains

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moisture well, and is suited to orchards, grain, and alfalfa. In its natural condition it supports a scattering growth of sagebrush, wild currant, juniper, and in places large rabbit brush.

The results of the mechanical analyses of fine-earth samples of the soil and subsoil of this type are shown in the following table:

Mechanical analyses of Yakima loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19713	Soil	1.1	4.9	5.6	15.1	14.2	46.2	12.4
19714	Subsoil	.7	3.2	2.9	9.1	22.6	50.9	10.1

YAKIMA CLAY ADOBE.

The Yakima clay adobe is a dark-brown or almost black soil, residual in origin and resting on the parent basaltic rock from which it was derived, or in some cases upon the "chalk" of the valley floor. It varies in depth from 2 to 4 feet or more and often contains irregular fragments and blocks of basalt, which in places are sufficiently numerous to interfere with cultivation. When dry this soil breaks into the small irregular cubelike pieces characteristic of adobe soils. As found in this area the soil is not very uniform, many portions of it being a loam in texture and in some places the adobe structure is also wanting. Although small areas occur in a number of places, only two of these are of sufficient extent to be shown in the map, one at Klamath Falls and the other on the east side of Langell Valley.

The Yakima clay adobe is rather difficult to cultivate, especially if not in the proper moisture condition, but if well drained it is a durable, productive soil suited to the crops of the area.

The results of mechanical analyses of the soil and subsoil of this type are shown in the following table:

Mechanical analyses of Yakima clay adobe.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18679	Soil	0.1	1.1	0.4	1.3	2.6	60.1	34.7
18680	Subsoil	.5	2.4	2.8	8.6	7.4	54.7	23.3

KLAMATH SERIES.

The soils of the Klamath series are alluvial and lacustrine in origin, occurring as stream flood plains, frequently or occasionally overflowed, and as the beds and margin of shallow lakes.

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The soils consist of basaltic material, volcanic ash, and diatomaceous earth of the Yakima series reworked, deposited, and modified by the action of the water and by the addition of organic matter, which in many places forms a very high percentage of the soil.

In color these soils vary from dark gray when dry to black when wet. The subsoil is lighter in color and usually lighter in texture than the surface soil. Much of the soil of this series carries an appreciable quantity of alkali, especially that along the lake margins.

Where free from excess of alkali and well drained these soils should prove very productive.

KLAMATH FINE SANDY LOAM.

The Klamath fine sandy loam is a gray, dark gray, and, in places, almost black fine sandy loam. It is smooth and uniform in texture, friable, and easily cultivated. At a depth of about 15 inches the surface soil grades into a gray light fine sandy loam which extends to a depth of 6 feet or more. Near the contact between the soil and subsoil the texture is usually heaviest and in some places at about this depth a thin, slightly cemented layer is encountered.

The Klamath fine sandy loam is usually comparatively free from alkali, although in places it carries small quantities.

This soil occurs in small bodies along Lost River and its tributaries and has been deposited largely by flood waters from those streams. Where this soil occurs adjacent to the Yakima fine sandy loam of the lower valley phase there is no sharp boundary line between them.

In its natural state the Klamath fine sandy loam supports a dense growth of sagebrush and large rabbit brush. Where cleared and prepared for irrigation it is well suited to alfalfa, grain, or garden truck.

The results of mechanical analyses of the soil and subsoil of this type are shown in the following table:

Mechanical analyses of Klamath fine sandy loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
18936	Soil	0.0	1.4	1.0	31.7	11.1	38.0	17.6
18937	Subsoil	.0	1.0	2.1	41.3	12.7	27.1	15.2

KLAMATH LOAM.

The Klamath loam consists of an ashy-gray, dark-gray or almost black loam to a depth of from 1 to 3 feet, underlain by a gray loam or in some cases by a gray, sticky fine sandy loam, which may

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extend to a depth of 6 feet or more, or may be underlain by the "chalk." The surface of this soil often appears gray from the tufaceous material which it contains, but in many of the lower lying areas it is quite black. In most places it carries alkali, but only in the small basinlike depressions and in the areas along the margins of the marshes is the quantity sufficient to be injurious.

When wet this soil is in places mucky and sticky, but when in the optimum moisture conditions it is friable and easily cultivated.

The principal areas of Klamath loam occur in the lower parts of Yonna, Langell, and Poe valleys, and along the margin of the marsh lands of Lower Klamath Lake. There are also a few small areas of this soil in Klamath Valley east of Lost River and along Lost River Slough. As in the case of the fine sandy loam, there are in places no sharp lines of demarcation between the black loam of the Klamath series and the brown residual and colluvial loam of the Yakima series.

The native growth of this soil consists principally of sagebrush, usually rather stunted, large rabbit brush, salt grass, and other alkali-resistant plants.

It is dry farmed to grain and potatoes to a limited extent. Alfalfa does not produce so well as on the sandier soils, although grain crops are often much heavier. Where well drained and irrigated it will be found well adapted to redtop, timothy, red clover, and other crops suited to the climate.

The average results of mechanical analyses of the soil and subsoil of this type are shown in the following table:

Mechanical analyses of Klamath loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19317, 19322, 19715.	Soil.....	0.4	6.7	5.8	17.6	7.8	43.9	17.2
19318, 19323, 19716.	Subsoil.....	.5	5.7	7.2	25.3	15.3	28.1	17.6

The following samples contained more than one-half of 1 per cent of calcium carbonate ($CaCO_3$): No. 19317, 6.56 per cent; No. 19318, 0.66 per cent.

A determination of the organic matter gave the following percentages: No. 19317, 26.20 per cent; No. 19318, 0.56 per cent.

KLAMATH CLAY ADOBE.

The surface soil of the Klamath clay adobe is ashy gray in color when dry and black when moist. It extends to a depth of about 30 inches, below which it grades into a yellowish silty clay loam, loam, or sometimes into a sandy loam, the subsoil always being lighter in color and texture than the surface soil. The dark-colored surface soil is a true adobe, cracking badly, wide cracks often extending to the subsoil, and when broken it separates into little cubes.

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The principal bodies of the Klamath clay adobe lie along Lost River in Langell and Poe valleys, where the soil has been formed from material brought into the valleys by the river. The color is due in a large part to the high organic matter content. Other small bodies are found in the beds of small shallow lakes near the marsh. These were in most cases too small to be shown on the map.

This soil along Lost River is used exclusively for pasture and mowing land, the native flags, bluestem, foxtail, and other grasses being cut for hay or grazed. In these small lake-bed areas this soil is usually strongly impregnated with alkali, and in portions of the Poe Valley it also contains alkali in small quantities, but in the remainder of the area it is comparatively free from injurious salts.

In order to farm this soil, both protection from overflow and provision for drainage would be necessary, but even then, on account of its refractory nature and the difficulty of handling it under irrigation, it would be poorly suited for farming. It is best suited to the raising of timothy and redtop, which do fairly well when a sod has once been established.

The results of mechanical analyses of the soil and subsoil of this type are shown in the following table:

Mechanical analyses of Klamath clay adobe.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19313	Soil	0.0	1.9	1.3	5.5	3.7	20.0	65.7
19314	Subsoil	.1	1.1	1.8	8.8	3.9	31.5	51.9
19315	Lower subsoil	.4	3.0	3.9	19.4	12.0	30.6	29.7

The following samples contained more than one-half of 1 per cent of calcium carbonate ($CaCO_3$): No. 19313, 2.90 per cent; No. 19314, 1.14 per cent.

A determination of the organic matter gave the following percentages: No. 19313, 2.57 per cent; No. 19314, 1.03 per cent.

PEAT.

The soil of the Klamath Lake basin is Peat and has been formed from the decomposition of tules in the swamps and shallow lake water. Its origin is rather recent, for the black tule peat and muck containing plant fiber and pieces of plants and roots extends in the heaviest deposit to a depth of 8 or 10 feet only. In similar soils elsewhere in California such deposits often occur to a depth of 40 feet. Water-bearing sands occur at shallow depths and heavy tufaceous and diatomaceous deposits devoid of fiber are found under all parts of the swamp and lake between the depths of 5 and 13 feet. These evidences of recent tule deposits tend to show that at one time there occurred a much greater flow of water into bodies of water much deeper than is now found and too deep for the growth of tules.

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By a decrease in regional rainfall and a wearing away of the barrier in the Klamath River at Keno the lake has become much shallower, enabling the growth of tules to cover more than three-fifths of the former lake surface. Overlapping of growing tules into the open water has caused pieces to break away, forming floating islands. These islands, lodging in shallow waters, form nuclei for further encroachments on the lake. This mass of tule roots and stems, making a dense mat on the surface and rotting away below, formed the present top soils of the swamp or marsh lands.

When the lake was deeper than at present, large quantities of volcanic tufa, ash, and pumice were washed into the lake from the surrounding mountains, which contain large deposits of these materials. Small siliceous plants called diatoms grew in such abundance that their siliceous casts formed very considerable deposits, markedly affecting the lake bottom deposits. As the lake subsided the tufaceous deposits became less pronounced, but the diatomaceous depositions continued until at present they form a large proportion of the tule, muck, and sludge of the upper soil of the swamps and lakes. This mixture of fine, light, volcanic and diatomaceous material gives these subsoils a plastic, slimy, and in places a somewhat rubbery consistency. The proportion of this material decreases rapidly as the soil surface is approached, where it becomes a minor part of the peat or muck. There exists in all cases sufficient quantities to turn the soils a light ashen-gray color when dry, but on subsequent wetting they revert to a dark-brown or black color.

In weight the tule soils are very light, all of them floating when dry and the tule mat always floating when becoming detached.

The tule soils are very porous, readily permitting the percolation of irrigation or rain water. The large admixture of fine tufaceous and diatomaceous material greatly increases the capillary power of the Peat, and more especially in the lower depth. Usually the first part of the tule mat is somewhat lacking in this respect. Where this tule mat has subsided and decomposed into a black fine-grained muck, as in the narrow strip along both sides of Klamath River, capillary power is greatly increased.

In structure and depth the Peat shows some variation, but a general uniformity. The tule mat consists of tangled roots and stems, with an addition of tufaceous and diatomaceous earth to a depth varying from 12 to 20 inches. Directly under this mat occurs a mass of muck and broken tules, usually very loose and watery. At depths varying from 5 to 9 feet this muck gives way to a bluish-gray tufaceous material which contains no roots or fiber, although heavily charged with organic matter. This material is usually loamy in texture, but varies in different parts of the swamp and lake, being much heavier, more compact, and drier in the southern part. In

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the northern part this subsoil is often replaced by coarse basaltic sand or sandy loam at depths varying from 3 to 7 feet. This condition usually occurs in the region of Klamath River.

In many other parts of the marsh lands boring to a depth of 15 feet showed similar conditions, with the tule muck varying from 5 to 9 feet in depth. In all cases there existed a sheet of water between the muck and the heavier material of the subsoil, which rose to within 2 feet or less of the surface when liberated.

While the main body of the Peat soil is described above, there are certain variations too small or too insignificant to map, such as black mucky loam, black loam, clay loam, and sludgy material. The black mucky loam is a light-textured soil consisting of well-rotted and finely decomposed tules showing no fiber. It is usually 6 feet in depth and occurs along the Klamath River and the outer edges of the adjacent swamps. It is usually slightly elevated above the surrounding region and is covered with wild grasses, such as bluestem, foxtail, juncus, salt grass, and bunch grass, which afford hay and pasturage. From its excellent capillary powers considerable alkali is accumulated on the soil surface in a white crust. On account of its low elevation but little of these salts is washed away, as is the case in the adjacent land.

About the edge of the swamps heavy black loam and clay loam occur in narrow strips. On the heavier of these soils no tules grow.

In the open waters of Lower Klamath Lake there is found a heterogeneous, sludgy mass of diatomaceous and tufaceous material, to which have been added disintegrated and rotted vegetable matter and fragments of diatoms and infusoria which teem in these waters. This material is dark colored when wet, but becomes gray when dry. It is extremely light in weight, but absorbs many times its weight in water. When drained it loses water very slowly and at all times will retain large quantities. In the bottom of the lake wholly submerged are found growing large quantities of seaweed and duckweed (*Lemna* sp.), which serve partially to hold this slimy sludge together. This ooze is so light and loose that wind disturbances moving the water pile it in masses in various parts of the lake. Where it extends to the surface of the water, tules often take root, forming a tule mat which in turn becomes Peat. In this manner the lake ooze is giving way to Peat. In depth this ooze or sludge may vary from 6 to 15 feet, where it is underlain by a solid bottom of gray or blue-gray diatomaceous and tufaceous loam or fine sandy loam filled with fragments of shells, mussels, and snails. This hard bottom underlying the water is much deeper than that underneath the Peat. Considerable quantities of black alkali occur uniformly throughout this ooze and would, unless drained out, interfere with crops when the land is reclaimed. It is classed as inferior soil material, but would, perhaps,

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when thoroughly drained, wear down into a muck soil which would be capable of supporting certain crops like redtop and others suited to the region.

The following results of chemical analyses are given by Heileman.[a]

The average of ten analyses showed calcium (CaO), 5.75 per cent; potash (K_2O), 0.25 per cent; phosphoric acid (P_2O_5), 0.22 per cent; total nitrogen (N), 1.10 per cent; loss on ignition (organic matter), 43.90 per cent.

The table below gives the results of a number of chemical analyses of material taken from Peat areas. These analyses were made in the Bureau laboratory.

Mineral constituents extracted by hydrochloric acid (Sp. g. 1.115), according to the method of the Association of Official Agricultural Chemists.

Sample and locality from which taken.	Constituents.				
	Phosphoric acid (P_2O_5).	Potash (K_2O).	Lime (CaO).	Aluminum oxide (Al_2O_3).	Ferric oxide (Fe_2O_3).
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19183. SE. ¼ sec. 34, T. 39 S., R. 9 E.; conglomerate, 33 to 37 inches	0.20	.....	1.43	6.21	4.95
19185. Klamath Falls. Yellow chalklike material along ditch	.03	0.12	.54	.....	.....
19285. SW. ¼, SW. ¼ sec. 17, T. 48 N., R. 2 E.; Peat, 0 to 12 inches	5.06	.40	4.90	.....	.....
19293. One-fourth mile S. cen. sec. 28, T. 48 N., R. 2 E.; Peat, 0 to 12 inches	.31	.11	1.73	.....	.....
19294. Under No. 19293; Peat, 12 to 60 inches	.14	.25	3.30	.....	.....
19295. Under No. 19294; Peat, 60 to 108 inches	.04	.06	.92	.....	.....
19296. Under No. 19295; Peat, 108 to 138 inches	.27	.19	.28	.....	.....
19297. Three-eighths mile E. cen. sec. 29, T. 48 N., R. 3 E.; Peat, 0 to 12 inches	.31	.12	.09	.....	.....
19298. Under No. 19297; Peat, 12 to 90 inches	.22	.18	9.29	.....	.....
19299. Under No. 19298; Peat, 90 to 150 inches	.11	.03	1.44	.....	.....
19307. One-half mile SW. cen. sec. 23, T. 40 S., R. 8 E.; Peat, 0 to 20 inches	.11	.43	1.62	.....	.....
19308. Under No. 19307; Peat, 20 to 60 inches	.11	.56	12.90	.....	.....
19309. Under No. 19308; Peat, 60 to 96 inches	.02	.27	3.37	.....	.....

To subdue the Peat areas for farming it will first be necessary to burn off the standing tules, drain the soil to a proper depth, and then plow the tule mat some time in advance of planting. Plowing should be done in the fall with light, sharp steel plows. The tule sod is usually turned over to a depth of 4 to 6 inches, allowed to settle, and then disked and later harrowed down with a drag harrow. The soil should then be ready for a spring crop of grain or potatoes. For preparing the land for grass or cultivated vegetables a crop or more

[a] Klamath, The California-Oregon Irrigation District created by the United States Government.

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of grain should be grown in order to render the soil uniformly fine and smooth. At least one season and perhaps two or three will be necessary to reduce the Peat to a state of perfect tilth.

The following table gives the average results of mechanical analyses of samples of Peat taken at four different depths:

Mechanical analyses of Peat.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19285, 19293, 19297, 19307, 19319.	Soil.....	5.2	32.0	9.0	8.9	1.1	27.5	16.5
19294, 19298, 19308.	Subsoil.....	3.3	23.4	6.8	7.5	1.1	35.0	23.0
19295, 19299, 19309.	Lower subsoil.	Tr.	2.5	3.6	35.1	10.1	29.2	20.0
19296.....	Third subsoil.	.2	2.6	4.4	7.9	1.2	50.4	33.9

A determination of the organic matter gave the following percentages: No. 19285, 44.80 per cent; No. 19293, 44.50 per cent; No. 19294, 31.40 per cent; No. 19295, 1.31 per cent; No. 19296, 1.55 per cent; No. 19297, 42.20 per cent; No. 19298, 35.70 per cent; No. 19299, 1.84 per cent; No. 19307, 79.85 per cent; No. 19308, 19.60 per cent; No. 19309, 1.59 per cent; No. 19319, 44.32 per cent.

Soil of Tule Lake Bed.

On the north side of Tule Lake the bed of the lake slopes to the south very gently, the fall being only 5 or 6 feet to the mile. When people first came into the Klamath Basin the lake occupied a much smaller area than at present, the old emigrant trail having passed along the north edge of the lake, where at present the water is from 10 to 15 feet deep. Even within the memory of present settlers the lake shore has advanced a considerable distance, in several places posts which once formed fences being now seen sticking out of the water half a mile from shore. This rise of the water, however, is not a constant one, being greater when wet seasons occur and less during seasons of lighter rainfall. For this reason it is believed that the rise of the water during recent years is due to a series of seasons of slightly increased rainfall, rather than to the stoppage of an underground outlet.

It is the purpose of the United States Reclamation Service to reclaim between 12,000 and 15,000 acres of this lake bed by lowering the water the necessary 15 feet or more. This is to be done by making a reservoir of Clear Lake, thus cutting off the water supply of Lost River and by turning the seepage water which enters Lost River from the Upper Project through a ditch into Klamath River. With a large part of the water supply cut off it is thought that evaporation alone will in a few years restore the lake to the old level.

In order to study the soils of the area which will be reclaimed in this way several borings were made in various parts of the lake bed

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under water 3 to 15 feet deep. In nearly all places where examinations were made the soil was found to be a smooth-textured light fine sand quite similar to, but lighter than, the narrow strip of fine sandy loam which extends along the lake shore between Adams Point and Bevins Point. In the shallow water near the shore this soil contains rather small quantities of organic matter, but in the deeper parts the soil is darker in color and contains more organic matter, probably due to the decay of tules which formerly grew along the lake margin but were killed by the rise of its waters. Along the lake shore north of Bloody Point and also south of the mouth of Lost River the soil is much coarser than along the north side of the lake, this coarser soil probably extending out into the lake for a considerable distance. It was very difficult to determine the depth of the soil in the lake bed, but from the borings made under water and along the edge of the lake it is believed to vary in depth from 2 to 4 feet and to be underlain, like the soils of the remainder of the valley, by the diatomaceous earth.

From the surface indications of alkali along the lake shore near the mouth of Lost River it might be concluded that the reclaimed lands would contain injurious quantities of salts. Careful examination of these soils shows, however, that the amount of alkali which they contain is small, being confined to the surface inch or two, below which there is only a trace. A lowering of the ground water by drainage and a thorough surface flooding should remove this surface alkali. An examination of all samples taken from the lake bed showed them to be free from alkali, and with the exception of two small spots no alkali was found in the soils or subsoils in the entire area east of Adams Point. If these soils when reclaimed are kept properly drained little is to be feared from the accumulation of alkali. They will be found well adapted to the growing of alfalfa, grain, potatoes, and all other crops suited to the sandy soils of the area.

The average results of the mechanical analyses of the Tule Lake bed soils are shown in the following table:

Mechanical analyses of soils from Tule Lake bed.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
19169, 19170, 19171, 19173, 19174, 19175, 19176, 19177.	Soil.....	0.6	4.7	4.8	47.0	25.4	12.6	4.8
19172.....	Subsoil....	.3	3.0	9.9	57.0	15.0	11.4	3.5

The following sample contained more than one-half of 1 per cent of calcium carbonate ($CaCO_3$): Nos. 19172, 1.92 per cent.

A determination of the organic matter gave the following percentages: No. 19169, 0.64 per cent; No. 19170, 0.70 per cent; No. 19171, 0.78 per cent; No. 19173, 1.32 per cent; No. 19174, 1.40 per cent; No. 19175, 0.94 per cent; No. 19176, 0.70 per cent; No. 19177, 1.84 per cent.

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IRRIGATION.

Irrigation, in a small way, has been practiced in the Klamath Basin for over twenty years, an irrigation ditch having been constructed by the Klamath Falls Irrigation Company in 1884, and another, known locally as the Adams ditch, by the Little Klamath Ditch Company, in 1885. Each of these systems has been enlarged from time to time. In addition to the land irrigated from these ditches there were a few small areas along Lost River irrigated from springs and by water raised from the river with water wheels. The total area irrigated, however, was probably not more than 25,000 acres.

Soon after the organization of the United States Reclamation Service engineers were sent to inspect the Klamath country with a view to organizing a reclamation project, a favorable report was received, a water users' association formed, sufficient lands signed up in the Lower Project, and in May, 1905, the project was formally accepted by the Secretary of the Interior. Bids for construction work were opened in December, 1905, and active work began early the next year, the Government purchasing the systems then in operation.

The area to be irrigated is to be divided into the Upper Project and the Lower Project, the latter consisting of Klamath Valley, a part of Poe Valley, the marsh lands, and the lands adjacent to Tule Lake, which are to be irrigated with water diverted from Upper Klamath Lake. The Upper Project consists of Langell and Yonna valleys and a part of Poe Valley to be irrigated with water stored in Clear Lake.

Sufficient land was not taken up in the Upper Project to permit its being accepted until 1908, when work on the storage reservoir was begun.

When both projects are completed there will be, including 50,000 acres of marsh lands, between 150,000 and 180,000 acres under irrigation.

The principal irrigated crop of the area is alfalfa. Water is applied to the fields early in the growing season and again a short time before each cutting, making three irrigations in all. Three methods of irrigation are used, the border method, the check system, and flooding from small laterals, the last two being the most extensively practiced, and so far as observed with about equal success. The tendency, however, seems to be toward overirrigation, especially where the check system is used, the water often being held on the checks for a much longer period than is necessary to bring the soil into a proper moisture condition.

On account of the readiness with which the sandy soils of this area take up the irrigation water, where the slope is not too great, the border method of irrigation is recommended. By this method the field to be irrigated is laid off into long, narrow strips separated by

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low, broad borders, these being 6 to 8 feet wide and not over 8 or 10 inches high. These strips extend entirely across the field with the slope of the land, there being no cross borders or checks. The soil between the borders should be made smooth and level from side to side, but should have a uniform slope from the upper to the lower end of the check. Water is admitted at the upper end of the checks and just enough used to reach the lower end, or if larger amounts are used the excess is carried off at the lower end by means of a drainage ditch. By regulating the head of water admitted the desired degree of moisture may be secured without overirrigation. This method also has the advantage of low borders easily crossed by machinery and has been used successfully where the fall is as much as 10 feet to the mile.

Grain is grown under irrigation as well as dry farmed. The fields are usually watered from small laterals when the grain has become of sufficient height to shade the ground well. In most cases one application of water is sufficient. In the areas of sand an irrigation before seeding to prevent the shifting of the sand has been used to some extent, but on account of the rapidity with which the surface of the sand dries out this practice has not been found very efficient.

IRRIGATION OF PEAT AREAS.

When the irrigation of the tule lands has progressed to a point where the growing of crops is possible irrigation will be necessary. In other marsh areas a system of subirrigation has been used successfully, and such a system has been suggested for this area. A subirrigation system requires a comparatively level surface such as the unreclaimed marshes present at present. That the marsh lands when drained and allowed to settle will have such a surface seems somewhat doubtful. This conclusion is based on the fact that the surface topography of the Klamath Basin wherever not covered by marsh is comparatively uneven, and that the water flowing into the marshes carries very little silt the deposition of which would tend to level the surface upon which the marsh rests. The level marsh as it exists now has developed through the extension of the edge of the tule mat over the water, thus covering many irregularities filled with water and ooze, which upon drying will again become uneven. That such a condition exists is indicated by the tendency of the Peat to sink at the edge when one walks on it near open water and by the readiness with which large areas may be made to shake like a jelly, thus indicating the unstable nature of the material between the surface mat and firm subsoil. There are also in many places through the marshes small bodies of open water and channels of considerable extent. For these reasons it is believed that when the marsh is allowed to settle the topography will be much too uneven for successful subirrigation. Another objection to the adoption of any system of subirrigation

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in this area is to be found in the danger from the surface accumulation of alkali.

Throughout the Klamath Basin alkali in varying quantities occurs in the soils and is especially troublesome wherever the "chalk" subsoil is covered by a shallow surface soil only or where conditions have been favorable for the accumulation of alkali at the surface. At almost all points along the edge of the marshes occurs a strip of soil so highly charged with alkali that it is unfit for crop use. This accumulation has resulted from circumstances favorable to the evaporation of alkali-charged water, and while representing conditions much more serious than those that would result from a system of subirrigation seems to indicate the danger of such a system.

In the Klamath Basin a considerable part of all the soluble salts consists of bicarbonates, which in the presence of large quantities of decomposing organic matter such as will be found in the marsh lands, would be readily converted to the more injurious carbonates or black alkali. Tests made along the edge of the marshes show that this change has, in those places, already taken place.

It is believed, then, that when the marsh lands have been reclaimed a system of irrigation which will provide for the application of the water at the surface accompanied by thorough drainage of the subsoil will in every way prove the safest and most satisfactory.

DRAINAGE.

One of the most serious problems of the Klamath area is lack of proper drainage. The surface soil of the area is so light and sandy and takes up the water so readily that the tendency to overirrigate is very great. The subsoil, however, as has already been noted, is in nearly all cases composed of a silty chalklike material which is more or less impervious. At or near the surface of this subsoil there are in many places thin layers of soft sandstone or hardpan and in others a well-cemented conglomerate. In most places this subsoil upon the application of water becomes soft and permits the penetration of plant roots and the slow passage of water. When irrigation water is applied in large quantities it sinks rapidly until it reaches the subsoil, where its progress is impeded. One result of this condition is to waterlog the lower part of the soil, the zone of saturation approaching the surface as more water is applied. An examination of the soil near an irrigated field during the irrigation season will almost invariably show the soil just above the subsoil to be saturated. In a saturated soil the air necessary for the best plant development is driven out and growth partly suspended. If this condition exists long the plant roots become diseased and die.

A second serious effect of overirrigation results from the water which has been checked by the heavier subsoil seeking an escape

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along the surface of the heavier layer. By this means it passes into the lower areas, filling the soil to the surface, and often forming shallow lakes and swamp areas. The extent of areas ruined in this way increases from year to year in most areas where excessive quantities of water are used in irrigation.

Although irrigation has been carried on in this area only a comparatively short time, considerable bodies of land have been seriously injured from lack of drainage, and there is scarcely an irrigated field in which more or less damage has not been done by excess of water.

The remedy is to be found in the construction of drainage ditches which will carry off the excess of water and in using the amount of irrigation water necessary for the best plant growth, but not an oversupply of it.

Drainage ditches are as necessary to a complete irrigation system as are the irrigation ditches.

ALKALI.

Alkali is found in all the soils of the Klamath area, the smallest quantities occurring in the well-drained sands and sandy loams of the hill slopes, where the quantity in most places is so small that it is not injurious.

In the "chalk" beds it occurs in much larger proportions, but varies greatly in different places, there being little more than a trace in some places and sufficient amounts to be quite injurious to plant growth in others. The waters of the hot springs of the area also carry a considerable amount of alkali.

The heaviest accumulations of alkali in the surface soil and subsoil occur in the lower portions of the numerous shallow basins, where it has been carried from the surrounding areas by the rains of the winter season and then left in the soil after the water has evaporated. Alkali occurs along the shores of some of the lakes and marshes, where the evaporation of water and the deposition of the alkali which it contains is continually going on. Other areas are encountered where the subsoil has been filled by excess of irrigation water. It is from the formation and extension of these latter areas that the greatest injury may be expected.

Although the sandy soils of the hill slopes in most places contain only a very small quantity of alkali, water that has percolated long distances through them and along the surface of the heavier subsoils becomes more or less strongly impregnated with these soluble salts. There are, however, places on the slopes where relatively large quantities of alkali occur, the white crystals of which are sometimes brought to the surface by the plow or in digging post holes. The ground water always contains an appreciable, although usually small, amount of alkali derived from these sources. If this ground water is

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not permitted to accumulate in basins, but is carried off by proper drainage, little or no harm is done, but if it is allowed to accumulate, when it has risen to within a certain distance of the surface the water is carried to the surface by capillarity and escapes into the air, but the alkali is left behind as a surface deposit. Continued evaporation and deposition results in a surface accumulation which no field crop can withstand. In this way considerable areas in the irrigated sections of the Klamath area have already been injured by alkali, and with the extension of irrigation these areas will not only become larger but others will be formed, unless provision is made for thorough drainage.

Where it is not possible to secure sufficient drainage, the surface accumulation of alkali can be greatly retarded by using as little water as possible on the surrounding, loose-textured, higher lying areas, and by keeping a crop on the soil during the growing season. When the soil is not covered by a crop the surface should be cultivated, thus breaking the capillary tubes in the soil, the most favorable conditions for the rise of alkali being a high water table and a bare, hard-packed soil.

In poorly drained areas where an accumulation of alkali has already taken place, the total quantity in the soil to a depth of 6 feet is often small and is frequently concentrated at the surface. Such areas can often be reclaimed by providing good drainage, thoroughly cultivating the soil, flooding it, cultivating again, and sowing at once to a rapidly growing crop, barley or oats being best. If only a partial stand is secured, as soon as the crop is harvested the ground should again be plowed and flooded and as soon as possible thereafter cultivated. By repeating this process for two or three years much land can be sufficiently freed from alkali to enable a good stand of alfalfa to be secured. Where the accumulation of alkali is heavy thorough drainage of the soil and continuous flooding for a considerable time may be necessary.

The essential steps in reclaiming any alkali soil are thorough drainage, surface flooding, cultivation, and growing crops. Reclamation at best, however, is a slow and expensive process, the necessity of which should, to as great an extent as possible, be avoided.

In the principal alkali sections of the Klamath area carbonates, bicarbonates, chlorides, and sulphates all are present in varying amounts. In some limited areas, however, and especially where white gypsum crystals of alkali are found in the subsoil no carbonates occur, but in all the principal alkali areas where there has been an accumulation through the collection of drainage or the rise of ground water, black alkali was found in amounts varying from only a trace to a high concentration.

In a vertical soil section the heaviest concentration of alkali is usually found at a depth of about 3 feet, unless it has been brought

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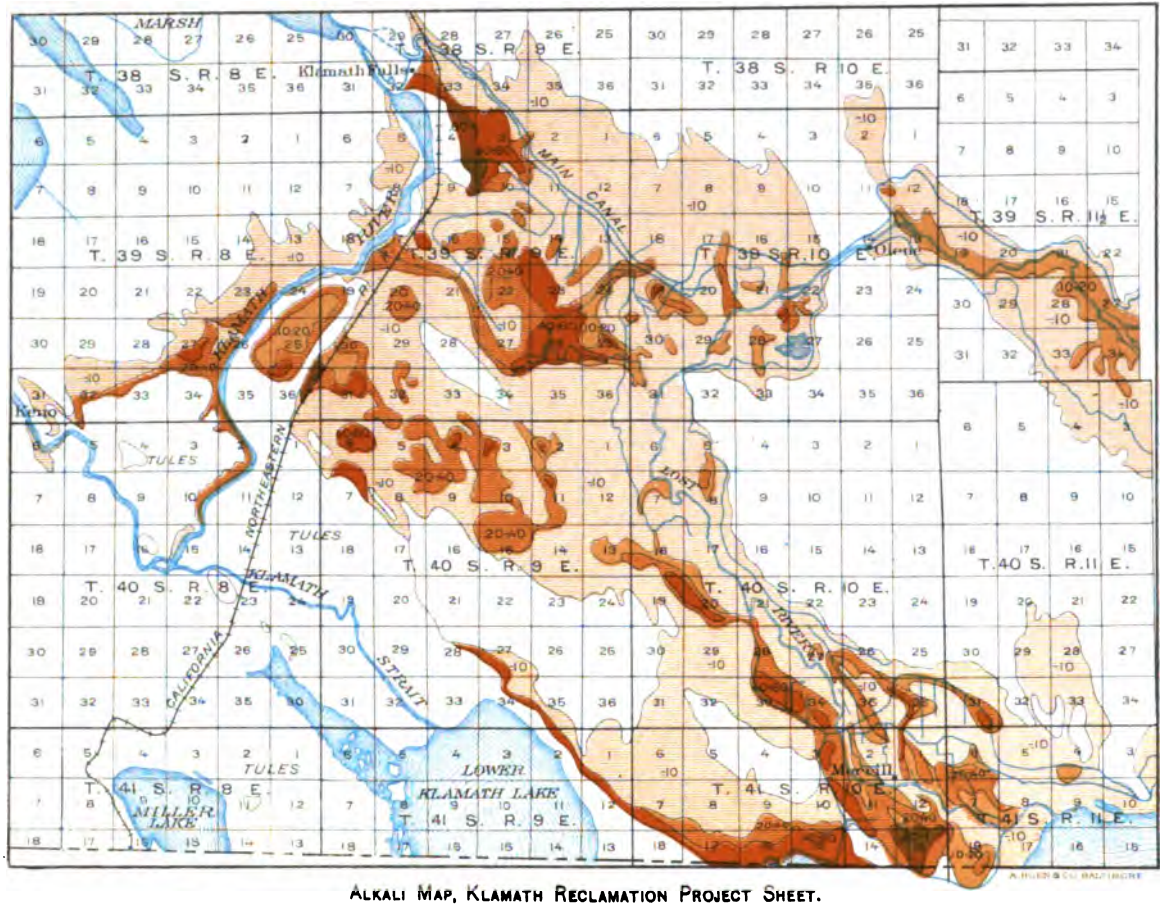
Report of the Bureau of Soils, U. S. Dept. Agr., 1908.



ALKALI MAP, KLAMATH RECLAMATION PROJECT SHEET.

LEGEND

Less than .10 per cent

From .10 per cent to .20 per cent

From .20 per cent to .40 per cent

From .40 per cent to .60 per cent

From .60 per cent to 1 per cent

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nearer the surface by the ground water or washed down by irrigation. At this depth it is much less injurious than when occurring at or near the surface. In the area places can be found in which a concentration of alkali in the surface foot of soil amounting to 0.2 of 1 per cent is seriously injuring the crops while in other places a concentration five times as great in the fourth or fifth foot seems to be in no way affecting them.

On the map accompanying this report (Pl. II) alkali areas of different concentrations are indicated by different colors. The outlining of these areas is based on numerous tests made to the depth of 6 feet, the average alkali content of the 6-foot section being indicated on the map. Thus it will be seen that the alkali map will not always agree with the surface appearance of the soil.

On account of the relatively large proportion of black alkali which occurs in nearly all parts of this area, a concentration of 0.2 to 0.4 of 1 per cent will be found to be injurious, in many places preventing the growing of a crop; these unproductive places usually occur, however, as small spots surrounded by more productive soil. Where more than 0.4 of 1 per cent occurs, especially if conditions are favorable for its concentration at the surface, crops can not be grown with any degree of success.

Even in those areas containing less than 0.2 of 1 per cent there are sections in which the alkali by its accumulation at the surface is proving somewhat harmful, and other sections in which there is danger of injury from such accumulation, although there are no indications of damage at present.

The following table gives the results of chemical analyses of a number of samples of alkali soils:

Chemical analyses of alkali soils.

Constituents.	18679. Center W. side sec. 33, T. 38 S., R. 9 E.; silt loam, 0 to 36 inches.	19312. SW. corner sec. 16, T. 47 N., R. 3 E.; tufa formation.	19313. One-fourth mile E. cen. sec. 24, T. 40 S., R. 13 E.; clay loam, 0 to 30 inches.	19314. Under No. 19313; clay loam, 30 to 52 inches.	19315. Under No. 19314; silty clay loam, 52 to 72 inches.	19316. One-third mile E. cen. sec. 10, T. 40 S., R. 8 E.; alkali crust, 0 to 1 inch.
Ions:	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Calcium (Ca)	2.04	0.04	0.00	0.00	0.72	0.08
Magnesium (Mg)	.58	.53	.42	1.14	1.13	.07
Sodium (Na)	25.36	35.56	29.05	27.35	25.51	39.98
Potassium (K)	5.83	1.04	.93	.85	.83	.52
Sulphuric acid (SO_4)	49.43	19.68	.00	20.54	8.76	.00
Chlorine (Cl)	6.12	18.29	7.80	4.55	3.59	.00
Bicarbonic acid (HCO_3)	10.64	6.46	42.62	45.57	59.46	12.99
Carbonic acid (CO_3)	.00	18.40	.00	.00	.00	46.36

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Chemical analyses of alkali soils—Continued.

Constituents.	18679. Center W. side sec. 33, T. 38 S., R. 9 E.; silt loam, 0 to 36 inches.	19312. SW. corner sec. 16, T. 47 N., R. 3 E.; tufa formation.	19313. One-fourth mile E. cen. sec. 24, T. 40 S., R. 13 E.; clay loam, 0 to 30 inches.	19314. Under No. 19313; clay loam, 30 to 52 inches.	19315. Under No. 19314; silty clay loam, 52 to 72 inches.	19316. One-third mile E. cen. sec. 10, T. 40 S., R. 8 E.; alkali crust, 0 to 1 inch.
Conventional combinations:	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Calcium sulphate ($CaSO_4$)	7.00	0.12	0.00	0.00	2.45	0.00
Potassium bicarbonate ($KHCO_3$)	.00	.00	.00	.00	.00	1.33
Sodium bicarbonate ($NaHCO_3$)	14.72	8.58	58.72	62.77	81.93	15.95
Sodium carbonate (Na_2CO_3)	.00	32.53	.00	.00	.00	81.96
Magnesium sulphate ($MgSO_4$)	2.77	2.64	2.07	5.65	5.63	.00
Potassium sulphate (K_2SO_4)	11.66	2.33	2.07	1.90	1.84	.00
Potassium chloride (KCl)	.00	.00	.00	.00	.00	.00
Sodium chloride (NaCl)	10.06	20.18	12.87	7.50	5.91	.00
Sodium sulphate (Na_2SO_4)	53.79	23.62	24.27	22.18	2.24	.00
Calcium bicarbonate ($Ca(HCO_3)_2$)	.00	.00	.00	.00	.00	.31
Magnesium bicarbonate ($Mg(HCO_3)_2$)	.00	.00	.00	.00	.00	.45
Per cent soluble	1.37	8.19	0.63	0.31	0.39	18.70

Constituents.	19317. SW. ¼ sec. 24, T. 39 S., R. 8 E.; mucky loam, 0 to 36 inches.	19318. Under No. 19317; sandy loam, 36 to 72 inches.	19319. One-fourth mile SW. cen. sec. 4, T. 41 S., R. 9 E.; peat, 0 to 72 inches.	19182. SW. ¼ sec. 18, T. 40 S., R. 10 E.; white soluble material, 20 to 40 inches.	19184. SE. corner sec. 36, T. 39 S., R. 8 E.; alkali crust from sink near Tule Lake, 0 to 3 inches.
Ions:	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Calcium (Ca)	2.04	1.13	2.03	15.82	0.04
Magnesium (Mg)	.00	.00	3.11	4.57	.01
Sodium (Na)	25.28	25.86	19.94	6.29	37.15
Potassium (K)	.69	1.30	3.51	1.88	.51
Sulphuric acid (SO_4)	2.86	8.08	19.05	67.44	6.53
Chlorine (Cl)	.00	.00	4.86	1.60	4.11
Bicarbonic acid (HCO_3)	67.76	63.63	47.50	2.40	20.06
Carbonic acid (CO_3)	1.37	.00	.00	.00	31.59
Conventional combinations:					
Calcium sulphate ($CaSO_4$)	4.05	3.84	6.90	53.80	.13
Potassium bicarbonate ($KHCO_3$)	1.76	.00	.00	.00	.00
Sodium bicarbonate ($NaHCO_3$)	88.26	87.68	65.44	2.31	27.51
Sodium carbonate (Na_2CO_3)	2.45	.00	.00	.00	55.85
Magnesium sulphate ($MgSO_4$)	.00	.00	15.40	22.65	.04
Potassium sulphate (K_2SO_4)	.00	2.87	3.42	4.17	1.15
Potassium chloride (KCl)	.00	.00	3.77	.00	.00
Sodium chloride (NaCl)	.00	.00	5.07	2.63	6.77
Sodium sulphate (Na_2SO_4)	.00	5.61	.00	13.44	8.55
Calcium bicarbonate ($Ca(HCO_3)_2$)	3.48	.00	.00	.00	.00
Magnesium bicarbonate ($Mg(HCO_3)_2$)	.00	.00	.00	.00	.00
Per cent soluble	0.42	0.25	0.74	3.50	76.37

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In cultivated fields the occurrence of alkali in injurious quantities, if near the surface, is indicated by spots of bare soil or by the stunted vegetation, by white surface accumulations, and, if black alkali is present, by black deposits on the soil, especially in the vicinity of poorly drained areas.

The best method of detecting an alkali soil is by an inspection of the wild vegetation which it supports. Some plants thrive only in a soil containing alkali, others grow equally well in an alkali soil or in one free from it, while still others avoid a soil containing alkali even in small amounts. A knowledge of these plants will often enable one to detect the presence of alkali even where there are no surface indications.

In the Klamath area the best indicator of alkali is the true greasewood (*Sarcobatus vermicularis*), a small shrub 2 to 4 feet high, resembling somewhat a small cedar and easily recognized by its luxuriant dark-green foliage, the leaves having the appearance of short, green, fleshy stems. The presence of this plant is a sure indication of alkali, and the larger, more vigorous plants are found where the concentration of alkali is heavier.

The best indicator of an alkali-free soil on uncultivated land is the black sage (*Artemesia tridentata*) known by its gray color, pungent sage odor, and by a peculiarity of its leaves, some of which have three lobes at the tip. Sage will not grow in an alkali soil, but since it is a shallow-rooted plant it may sometimes thrive in a soil the subsoil of which contains alkali. An example of this is to be found in the vicinity of White Lake City, where scattering plants of greasewood, which roots deeply, are found among a heavy growth of sage. As a rule, however, thrifty sage may be relied on as an indicator of alkali-free soil.

Large rabbit brush (*Chrysothamus nauseosus*), sometimes called yellow sage, is often mistaken for black sage, which it resembles somewhat in size and shape of plant, but it lacks the sage odor and instead of the three-lobed leaves it has a very narrow, sharp-pointed leaf. In the late summer the bright yellow flowers of this plant are very conspicuous in many parts of the area. The large rabbit brush seems to grow equally well in alkali and nonalkali soil, and its value as an indicator is to be found in the fact that on many areas of light sandy soil well suited for sage large rabbit brush has full possession. The soil in such areas usually contains alkali.

Death weed, or poverty weed (*Iva axillaris*), is also an alkali weed, thriving best where there is an appreciable amount, but also able to grow where alkali occurs in very small quantities.

Salt grass (*Distichlis spicata*), a short, harsh grass, growing in a close mat like Bermuda grass and having long, tough roots, grows only on alkali soil, but being able to thrive where there is very

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much or very little alkali, its chief value consists in aiding one to look for other indicators.

Salt brush, or salt weed (*Atriplex expansa*), and several smaller varieties are found throughout the area. This is a vigorous growing, broad spreading plant, with mealy silver-colored leaves. It thrives best on soils containing small but not excessive amounts of alkali.

Wild heliotrope (*Heliotropum curassavicum*), a low-growing, fleshy plant, with smooth, oval, succulent leaves, and spikes of dense white flowers growing on one side of the curved stem, is found on many of the areas of highest alkali concentration.

The waters in Klamath and Lost rivers and also in some of the springs of the area are remarkably free from alkali. The waters of Lower Klamath Lake and White Lake contain from 40 to 60 parts of soluble salts per 100,000, of which a considerable portion is carbonates and bicarbonates, while the waters of Miller Lake and also of some of the hot springs of the area contain a much higher percentage.

The following table gives the composition of the soluble salts in these waters:

Chemical analyses of water.

[Parts per 100,000.]

Constituents.	56. Lower Klamath Lake. T. 41 S., R. 9 E.	59. Lower Klamath Lake. ⅜ mi. W. cen. sec. 35, T. 48 N., R. 2 E.	62. Lower Klamath Lake. ½ mi. E. cen. sec. 17, T. 47 N., R. 3 E.	65. White Lake. NE. corner sec. 21, T. 48 N., R. 3 E.	79. Miller Lake. NE. ¼ sec. 15, T. 41 S., R. 8 E.	82. Willow Creek. NE. ¼ sec. 17, T. 47 N., R. 2 E.	86. Warm Spring. ½ mi. S. cen. sec. 17, T. 40 S., R. 9 E.
Ions:							
Calcium (Ca)	1.89	3.14	2.09	2.02	1.40	2.38	2.72
Magnesium (Mg)	1.36	1.63	1.99	1.63	2.69	1.06	2.06
Sodium (Na)	5.58	8.45	7.06	5.48	160.66	.57	6.19
Potassium (K)	3.06	4.87	3.18	2.21	25.06	1.23	2.53
Sulphuric acid (SO_4)	1.44	1.30	1.59	1.54	24.55	1.72	.00
Chlorine (Cl)	2.52	4.55	2.79	2.69	58.30	1.15	1.31
Bicarbonic acid (HCO_3)	22.52	34.11	29.52	23.26	225.40	11.89	33.00
Carbonic acid (CO_3)	1.62	1.96	1.79	1.15	61.77	.00	1.69
Conventional combinations:							
Calcium sulphate ($CaSO_4$)	1.98	1.84	2.29	2.24	4.70	2.46	0.00
Calcium chloride ($CaCl_2$)	3.69	7.15	3.87	3.75	.00	1.81	2.06
Magnesium chloride ($MgCl_2$)	.27	.00	40	.38	.00	.00	.00
Magnesium bicarbonate ($Mg(HCO_3)_2$)	7.57	9.75	11.34	9.23	.00	6.48	12.48
Potassium bicarbonate ($KHCO_3$)	7.83	12.46	8.15	5.58	.00	3.11	6.47
Sodium bicarbonate ($NaHCO_3$)	15.76	25.34	20.77	16.83	310.52	2.13	18.01
Sodium carbonate (Na_2CO_3)	2.88	3.46	3.18	2.02	109.20	.00	3.00
Magnesium sulphate ($MgSO_4$)	.00	.00	.00	.00	13.27	.00	.00
Potassium sulphate (K_2SO_4)	.00	.00	.00	.00	19.32	.00	.00
Potassium chloride (KCl)	.00	.00	.00	.00	30.64	.00	.00
Sodium chloride (NaCl)	.00	.00	.00	.00	71.34	.00	.00
Calcium bicarbonate ($Ca(HCO_3)_2$)	.00	.00	.00	.00	.00	4.01	7.98
Total solids	40.00	60.00	50.00	40.00	560.00	20.00	50.00

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SUMMARY.

The Klamath area has an elevation of over 4,000 feet, consists of several valleys separated by hills and mountains (the eastern outliers of the Cascade Range), and abounds in lakes and marshes.

On account of its isolation settlement has been very slow, but has been recently stimulated by the extension of the railroad, by its selection as a reclamation project, and by a thorough advertising of the country.

The climate is semiarid and temperature equable, yet on account of frosts the growing season is short.

Agriculture is comparatively undeveloped, but through the extension of irrigation, the introduction of alfalfa, and successful grain growing, general farming in the valleys is rapidly taking the place of exclusive stock raising. The country seems well suited for this and especially for the development of an important dairy business, but there is much opportunity for improvement by the adoption of more intensive methods of farming and by the introduction of new crops, of which Canadian field peas, sugar beets, timothy, and alfalfa for seed are among the most important.

The soils consist of marsh soils and upland soils. The upland soils, being composed largely of disintegrated basalt, volcanic ash, and diatomaceous earth, are friable, easily cultivated, and in general productive. The marsh soils contain a high percentage of organic matter, and although they have been used to only a small extent, it is believed that when reclaimed they will also prove rich and productive.

Of the upland soils the more productive are the deeper, well drained, and alkali-free sands, sandy loams, and fine sandy loams, all of which are especially well suited for the production of alfalfa.

The water supply is abundant and the tendency is toward overirrigation with serious results following from lack of drainage and the surface accumulation of alkali.

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APPENDIX.

The demand for the annual Reports of Field Operations of the Bureau of Soils in the past has been so great that the quota allotted to the Department for distribution to exchanges, libraries, and other public institutions and to private persons cooperating has been reduced to such an extent that it will be necessary to restrict the distribution of the bound volumes of these publications as much as possible.

Many applications for the reports named are from persons interested in only one or two areas, and to provide for such requests separate reprints of the reports and maps in pamphlet form, covering each of the areas surveyed, have been obtained, which will in many cases answer the purpose of the correspondent. A list of these reports and reprints follows, and any available reprint desired will be forwarded upon application to the Chief of the Bureau of Soils.

Copies of the bound volumes are on sale by the Superintendent of Documents, Government Printing Office, Washington, D. C., at the prices named.

Field Operations of the Division of Soils, 1899. (First Report.) By Milton Whitney, Chief of Division. With accompanying papers by Thomas H. Means, Frank D. Gardner, Clarence W. Dorsey, Frank K. Cameron, and Lyman J. Briggs. Pp. 198, pls. 29. figs. 19, lithograph maps 11. 1900. Price 95 cents.

REPRINTS.

A Reconnoissance in the Cache la Poudre Valley, Colorado. By Thomas H. Means. (Reprint exhausted.)

A Soil Survey in the Connecticut Valley, Connecticut and Massachusetts (parts of Hartford (Conn.) and Hampden counties, Mass., 388 square miles): One soil map. By Clarence W. Dorsey and Jay A. Bonsteel. (Reprint exhausted.)

A Soil Survey in the Pecos Valley, New Mexico (parts of Eddy and Chaves counties, 129 square miles): Two soil maps, 2 alkali maps, 2 underground water maps. By Thomas H. Means and Frank D. Gardner. (Reprint exhausted.)

A Soil Survey in Salt Lake Valley, Utah (part of Salt Lake County, 249 square miles): One soil map, 1 alkali map, 1 black alkali map, 1 underground water map. By Frank D. Gardner and John Stewart. (Reprint exhausted.)

A Reconnoissance in Sanpete, Cache, and Utah Counties, Utah. By Thomas H. Means. (Reprint exhausted.)

Field Operations of the Division of Soils, 1900. (Second Report.) By Milton Whitney, Chief of Division. With accompanying papers by Thomas H. Means, Frank D. Gardner, Clarence W. Dorsey, Jay A. Bonsteel, William G. Smith, J. Garnett Holmes, Frank K. Cameron, Lyman J. Briggs, and Marcus L. Floyd. Pp. 474, pls. 51, figs. 47, lithograph maps 24. 1901. Price $1.80.

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REPRINTS.

Soil Survey in Salt River Valley, Arizona (part of Maricopa County, 449 square miles): Three soil maps. By Thomas H. Means. (Maps exhausted.)

Soil Survey around Fresno, California (parts of Fresno and Tulare counties, 628 square miles): One soil map, 1 alkali map. By Thomas H. Means and J. Garnett Holmes. (Reprint exhausted.)

Soil Survey around Santa Ana, California (part of Orange County, 275 square miles): One soil map, 1 alkali map. By J. Garnett Holmes. (Reprint exhausted.)

Soil Survey of Cecil County, Maryland (376 square miles): One soil map. By Clarence W. Dorsey and Jay A. Bonsteel.

Soil Survey of St. Mary County, Maryland (363 square miles): One soil map. By Jay A. Bonsteel. (Reprint exhausted.)

Soil Survey of Calvert County, Maryland (217 square miles): One soil map. By Jay A. Bonsteel and R. T. Avon Burke.

Soil Survey of Kent County, Maryland (293 square miles): One soil map. By Jay A. Bonsteel.

Soil Survey from Raleigh to Newbern, North Carolina (parts of Craven, Jones, Wake, Johnston, Wayne, Greene, and Lenoir counties, 965 square miles): One soil map. By Wm. G. Smith. (Map exhausted.)

Soil Survey of Montgomery County, Ohio (480 square miles): One soil map. By Clarence W. Dorsey and George N. Coffey.

A Soil Survey around Lancaster, Pennsylvania (part of Lancaster County, 269 square miles): One soil map. By Clarence W. Dorsey.

Soil Survey of Weber County, Utah (310 square miles): One soil map, 1 alkali map, 1 underground water map. By Frank D. Gardner and Charles A. Jensen.

Soil Survey in the Sevier-Valley, Utah (parts of Sevier and Sanpete counties, 235 square miles): Two soil maps, 2 alkali maps. By Frank D. Gardner and Charles A. Jensen.

Field Operations of the Bureau of Soils, 1901. (Third Report.) By Milton Whitney, Chief of Bureau. With accompanying papers by assistants in charge of field parties. Pp. 647, pls. 96, figs. 25, lithograph maps 31. 1902. Price $2.25.

REPRINTS.

Soil Survey of the Hanford Area, California (parts of Fresno and Kings counties, 216 square miles): One soil map, 1 alkali map, 1 black alkali map (colored plate), 1 underground water map (colored plate). By Macy H. Lapham and W. H. Heileman.

Soil Survey of the Lower Salinas Valley, California (part of Monterey County, 344 square miles): Two soil maps, 1 underground water map (colored plate). By Macy H. Lapham.

Soil Survey of the Ventura Area, California (part of Ventura County, 240 square miles): One soil map, 1 alkali map. By J. Garnett Holmes and Louis Mesmer.

Soil Survey of the San Gabriel Area, California (parts of Los Angeles and San Bernardino counties, 259 square miles): One soil map. By J. Garnett Holmes and Louis Mesmer. (Reprint exhausted.)

Soil Survey of the Imperial Area, California (part of San Diego County, 169 square miles): One soil map, 1 alkali map. By Thomas H. Means and J. Garnett Holmes.

Soil Survey of Cobb County, Georgia (346 square miles): One soil map. By R. T. Avon Burke and Herbert W. Marean.

Soil Survey of the Covington Area, Georgia (parts of Jasper, Newton, Walton, Morgan, and Rockdale counties, 225 square miles): One soil map. By Herbert W. Marean.

Soil Survey of the Boise Area, Idaho (parts of Ada and Canyon counties, 399 square miles): Two soil maps, 1 alkali map, 1 black alkali map. By Charles A. Jensen and B. A. Olshausen.

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Soil Survey of the Lake Charles Area, Louisiana (part of Calcasieu Parish, 202 square miles): One soil map. By W. H. Heileman and Louis Mesmer.

Soil Survey of Prince George County, Maryland (480 square miles): One soil map. By Jay A. Bonsteel and party.

Soil Survey of Harford County, Maryland (418 square miles): One soil map. By W. G. Smith and J. O. Martin.

Soil Survey of Allegan County, Michigan (828 square miles): One soil map. By Elmer O. Fippin and Thomas D. Rice.

Soil Survey of the Yazoo Area, Mississippi (parts of Yazoo, Sharkey, and Issaquena counties, 656 square miles): Two soil maps. By Jay A. Bonsteel and party.

Soil Survey of the Salem Area, New Jersey (parts of Gloucester, Salem, and Cumberland counties, 493 square miles): One soil map. By Jay A. Bonsteel and F. W. Taylor.

Soil Survey of the Westfield Area, New York (part of Chautauqua County, 260 square miles): One soil map. By R. T. Avon Burke and Herbert W. Marean.

Soil Survey of Statesville Area, North Carolina (parts of Iredell, Mecklenburg, Lincoln, Catawba, Rowan, and Davie counties, 784 square miles): One soil map. By Clarence W. Dorsey and party.

Soil Survey of Alamance County, North Carolina (365 square miles): One soil map. By George N. Coffey and W. Edward Hearn.

Soil Survey of the Cary Area, North Carolina (part of Wake County, 63 square miles): One soil map (colored plate). By George N. Coffey and W. Edward Hearn. (Reprint exhausted.)

Soil Survey of the Lebanon Area, Pennsylvania (parts of Lancaster, Lebanon, and Dauphin counties, 669 square miles): One soil map. By W. G. Smith and Frank Bennett, jr.

Soil Survey of Montgomery County, Tennessee (547 square miles): One soil map. By J. E. Lapham and M. F. Miller. (Reprint exhausted.)

Soil Survey of the Willis Area, Texas (part of Montgomery County, 215 square miles): One soil map (colored plate). By J. O. Martin.

Soil Survey of the Bedford Area, Virginia (parts of Bedford, Botetourt, and Roanoke counties, 632 square miles): One soil map. By Charles N. Mooney, F. O. Martin, and Thomas A. Caine.

Soil Survey of the Prince Edward Area, Virginia (parts of Prince Edward, Lunenburg, Charlotte, Nottoway, and Amelia counties, 430 square miles): One soil map. By Charles N. Mooney and Thomas A. Caine.

Soil survey of the Yakima Area, Washington (part of Yakima County, 309 square miles): Two soil maps, 1 alkali map (colored plate), 1 black alkali map (colored plate), 2 underground water maps (colored plates). By Charles A. Jensen and B. A. Olshausen.

Field Operations of the Bureau of Soils, 1902. (Fourth Report.) By Milton Whitney, Chief. With accompanying papers by assistants in charge of field parties. Pp. 842, pls. 60, figs. 25, maps. 44. 1904. Price, cloth, $3.80.

REPRINTS.

Soil Survey of Perry County, Alabama (762 square miles): One soil map. By R. T. Avon Burke and party.

Soil Survey of the Yuma Area, Arizona (part of Yuma County, 99 square miles): One soil map, 1 alkali map. By J. Garnett Holmes.

Soil Survey of the Stuttgart Area, Arkansas (part of Arkansas County, 251 square miles): One soil map. By J. E. Lapham.

Soil Survey of the Lower Arkansas Valley, Colorado (parts of Otero, Bent, Prowers, and Kiowa counties, 945 square miles): Four soil maps, 4 alkali maps (colored plates), 4 underground water maps (colored plates). By Macy H. Lapham and party.

Soil Survey of the Lewiston Area, Idaho (parts of Nez Perce and Latah counties, 308 square miles): One soil map. By Louis Mesmer.

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Soil Survey of Tazewell County, Illinois (645 square miles): One soil map. By Jay A. Bonsteel, George N. Coffey, and party, in cooperation with the Illinois Experiment Station.

Soil Survey of Clinton County, Illinois (491 square miles): One soil map. By Jay A. Bonsteel and party, in cooperation with the Illinois Experiment Station.

Soil Survey of St. Clair County, Illinois (650 square miles): One soil map. By George N. Coffey and party, in cooperation with the Illinois Experiment Station.

Soil Survey of Clay County, Illinois (460 square miles): One soil map. By George N. Coffey and party, in cooperation with the Illinois Experiment Station.

Soil Survey of Posey County, Indiana (387 square miles): One soil map. By Herbert W. Marean.

Soil Survey of the Dubuque Area, Iowa (parts of Dubuque, Jackson, and Jones counties, Iowa, and Jo Daviess County, Ill., 440 square miles): One soil map. By Elmer O. Fippin.

Soil Survey of the Wichita Area, Kansas (parts of Sedgwick and Butler counties, 465 square miles): One soil map. By J. E. Lapham and B. A. Olshausen.

Soil Survey of Union County, Kentucky (361 square miles): One soil map. By Herbert W. Marean.

Soil Survey of the Smedes Area, Mississippi (parts of Yazoo, Madison, Issaquena, and Sharkey counties, 463 square miles): Two soil maps. By William G. Smith and William T. Carter, jr.

Soil Survey of Howell County, Missouri (919 square miles): One soil map. By Elmer O. Fippin and James L. Burgess.

Soil Survey of the Billings Area, Montana (part of Yellowstone County, 107 square miles): One soil map, 1 alkali map, 1 underground water map, 1 colored plate. By Charles A. Jensen and N. P. Neill.

Soil Survey of the Trenton Area, New Jersey (parts of Hunterdon, Somerset, Middlesex, Mercer, Monmouth, Burlington, and Ocean counties, New Jersey, and Bucks County, Pennsylvania, 810 square miles): One soil map. By R. T. Avon Burke and Henry J. Wilder.

Soil Survey of the Bigflats Area, New York (parts of Chemung and Steuben counties, 223 square miles): One soil map. By Louis Mesmer and W. Edward Hearn.

Soil Survey of the Lyons Area, New York (parts of Wayne, Ontario, and Seneca counties, 515 square miles): One soil map. By W. Edward Hearn. (Reprint exhausted.)

Soil Survey of the Hickory Area, North Carolina (parts of Catawba, Lincoln, Burke, Caldwell, Alexander, and Iredell counties, 988 square miles): Two soil maps. By Thomas A. Caine.

Soil Survey of the Mount Mitchell Area, North Carolina (parts of Yancey, Mitchell, Madison, Buncombe, and McDowell counties, 497 square miles): One soil map. By Thomas A. Caine and A. W. Mangum.

Soil Survey of the Grand Forks Area, North Dakota (part of Grand Forks County, 314 square miles): One soil map, 1 alkali map (colored plate), 1 underground water map (colored plate). By Charles A. Jensen and N. P. Neill.

Soil Survey of the Toledo Area, Ohio (parts of Lucas, Wood, and Ottawa counties, Ohio, and Monroe County, Mich., 403 square miles): One soil map. By William G. Smith.

Soil Survey of the Columbus Area, Ohio (parts of Franklin, Pickaway, Licking, Madison, and Fairfield counties, 472 square miles): One soil map. By William G. Smith.

Soil Survey of the Abbeville Area, South Carolina (parts of Abbeville, Anderson, Greenwood, and Laurens counties, 1,006 square miles): Two soil maps. By F. W. Taylor and Thomas D. Rice.

Soil Survey of the Darlington Area, South Carolina (part of Darlington County, 595 square miles): One soil map. By Thomas D. Rice and F. W. Taylor.

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Soil Survey of the Brazoria Area, Texas (part of Brazoria County, 845 square miles): Two soil maps. By Frank Bennett, jr., and Grove B. Jones. (Reprint exhausted.)

Soil Survey of the Vernon Area, Texas (part of Wilbarger County, 277 square miles): One soil map. By J. E. Lapham and party.

Soil Survey of the Albemarle Area, Virginia (parts of Albemarle, Buckingham, Greene, Augusta, Nelson, Page, and Rockingham counties, 1,410 square miles): Three soil maps. By Charles N. Mooney and F. E. Bonsteel.

Soil Survey of the Walla Walla Area, Washington (part of Wallawalla County, 201 square miles): One soil map, 1 black alkali map (colored plate). By J. Garnett Holmes.

Soil Survey of the Janesville Area, Wisconsin (parts of Rock and Dane counties, 451 square miles): One soil map. By Jay A. Bonsteel.

Soil Survey from Arecibo to Ponce, Porto Rico (330 square miles): One soil map. By Clarence W. Dorsey, Louis Mesmer, and Thomas A. Caine.

Field Operations of the Bureau of Soils, 1903. (Fifth Report.) By Milton Whitney, Chief. With accompanying papers by assistants in charge of field parties. Pp. 1,310, figs. 61, maps 78. 1904. Price $6.35.

ADVANCE SHEETS.

Soil Survey of the Fort Payne Area, Alabama (parts of Dekalb and Cherokee counties, 509 square miles): One soil map. By Grove B. Jones and M. E. Carr.

Soil Survey of the Huntsville Area, Alabama (parts of Limestone and Madison counties, 506 square miles): One soil map. By Frank Bennett, jr., and A. M. Griffen.

Soil Survey of the Mobile Area, Alabama (part of Mobile County, 461 square miles): One soil map. By R. T. Avon Burke and party.

Soil Survey of the Solomonsville Area, Arizona (part of Graham County, 108 square miles): One soil map, 1 alkali map (Plate I). By Macy H. Lapham and N. P. Neill.

Soil Survey of Miller County, Arkansas (626 square miles): One soil map. By J. O. Martin and E. P. Carr.

Soil Survey of the Imperial Area, California (part of San Diego County, 1,084 square miles): One soil map, 1 alkali map. By J. Garnett Holmes and party. (Exhausted.)

Soil Survey of the Indio Area, California (part of Riverside County, 234 square miles): One soil map, 1 alkali map. By J. Garnett Holmes and party.

Soil Survey of the Los Angeles Area, California (parts of Los Angeles and Orange counties, 570 square miles): One soil map, 1 alkali map. By Louis Mesmer.

Soil Survey of the San Jose Area, California (parts of Santa Clara and Alameda counties, 313 square miles): One soil map. By Macy H. Lapham. (Exhausted.)

Soil Survey of the San Luis Valley, Colorado (parts of Saguache, Rio Grande, and Costilla counties, 628 square miles): One soil map, 1 alkali map. By J. Garnett Holmes.

Soil Survey of the Connecticut Valley (parts of Hartford County, Conn., and Franklin, Hampshire, and Hampden counties, Mass., 1,314 square miles): Two soil maps. By Elmer O. Fippin.

Soil Survey of the Dover Area, Delaware (part of Kent County, 314 square miles): One soil map. By F. E. Bonsteel and O. L. Ayrs.

Soil Survey of Gadsden County, Florida (548 square miles): One soil map. By Elmer O. Fippin and Aldert S. Root.

Soil Survey of the Fort Valley Area, Georgia (parts of Macon and Houston counties, 186 square miles): One soil map. By William G. Smith and William T. Carter, jr.

Soil Survey of the Blackfoot Area, Idaho (parts of Fremont and Bingham counties, 428 square miles): Two soil maps. By W. E. McLendon.

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Soil Survey of Johnson County, Illinois (339 square miles): One soil map. By George N. Coffey and party.

Soil Survey of Knox County, Illinois (717 square miles): One soil map. By George N. Coffey and party.

Soil Survey of McLean County, Illinois (1,159 square miles): One soil map. By George N. Coffey and party.

Soil Survey of Sangamon County, Illinois (866 square miles): One soil map. By George N. Coffey and party.

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Soil Survey of Story County, Iowa (576 square miles): One soil map. By Herbert W. Marean and Grove B. Jones.

Soil Survey of the Parsons Area, Kansas (parts of Labette and Cherokee counties, 398 square miles): One soil map. By J. A. Drake.

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Soil Survey of the Ouachita Area, Louisiana (part of Ouachita Parish, 605 square miles): One soil map. By Thomas D. Rice and George N. Coffey.

Soil Survey of Worcester County, Maryland (463 square miles): One soil map. By F. E. Bonsteel and William T. Carter, jr. (Exhausted.)

Soil Survey of the Pontiac Area, Michigan (part of Oakland County, 307 square miles): One soil map. By Henry J. Wilder and W. J. Gelb.

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Soil Survey of the McNeill Area, Mississippi (parts of Pearl River and Hancock counties, 198 square miles): One soil map. By William G. Smith and William T. Carter, jr.

Soil Survey of the Grand Island Area, Nebraska (parts of Hall, Buffalo, and Hamilton counties, 446 square miles): One soil map. By W. Edward Hearn and James L. Burgess.

Soil Survey of the Stanton Area, Nebraska (parts of Pierce, Wayne, Madison, and Stanton counties, 323 square miles): One soil map. By W. Edward Hearn and James L. Burgess.

Soil Survey of the Long Island Area, New York (parts of Kings, Queens, Nassau, and Suffolk counties, 845 square miles): Two soil maps. By Jay A. Bonsteel and party. (Exhausted.)

Soil Survey of the Syracuse Area, New York (parts of Oswego and Onondaga counties, 416 square miles): One soil map. By F. E. Bonsteel, William T. Carter, jr., and O. L. Ayrs.

Soil Survey of the Asheville Area, North Carolina (parts of Buncombe, Madison, and Haywood counties, 497 square miles): One soil map. By J. E. Lapham and F. N. Meeker.

Soil Survey of the Craven Area, North Carolina (parts of Pitt, Craven, and Jones counties, 897 square miles): One soil map. By George N. Coffey and William G. Smith.

Soil Survey of the Fargo Area, North Dakota (part of Cass County, 406 square miles): One soil map. By Thomas A. Caine.

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Soil Survey of the Jamestown Area, North Dakota (parts of Stutsman and Barnes counties, 496 square miles): One soil map. By Thomas A. Caine and A. E. Kocher.

Soil Survey of the Ashtabula Area, Ohio (part of Ashtabula County, 340 square miles): One soil map. By J. O. Martin and E. P. Carr.

Soil Survey of the Baker City Area, Oregon (part of Baker County, 158 square miles): One soil map, 1 alkali map, 1 black alkali map, 1 underground water map. By Charles A. Jensen and W. W. Mackie.

Soil Survey of the Salem Area, Oregon (parts of Marion and Polk counties, 284 square miles): One soil map. By Charles A. Jensen.

Soil Survey of the Lockhaven Area, Pennsylvania (part of Clinton County, 278 square miles): One soil map. By J. O. Martin.

Soil Survey of the Campobello Area, South Carolina (parts of Greenville and Spartanburg counties, 515 square miles): One soil map. By A. W. Mangum and Aldert S. Root.

Soil Survey of the Brookings Area, South Dakota (part of Brookings County, 484 square miles): One soil map. By Frank Bennett, jr.

Soil Survey of Davidson County, Tennessee (501 square miles): One soil map. By William G. Smith and Hugh H. Bennett.

Soil Survey of the Pikeville Area, Tennessee (parts of Van Buren, Bledsoe, Rhea, and Sequatchie counties, 440 square miles): One soil map. By Henry J. Wilder and W. J. Geib.

Soil Survey of the Jacksonville Area, Texas (part of Cherokee County, 100 square miles): One soil map. By W. Edward Hearn and James L. Burgess.

Soil Survey of the Lufkin Area, Texas (part of Angelina County, 99 square miles): One soil map. By W. Edward Hearn and party.

Soil Survey of the Nacogdoches Area, Texas (part of Nacogdoches County, 97 square miles): One soil map. By W. Edward Hearn and James L. Burgess.

Soil Survey of the Paris Area, Texas (part of Lamar County, 548 square miles): One soil map. By Thomas A. Caine and A. E. Kocher.

Soil Survey of the Woodville Area, Texas (part of Tyler County, 100 square miles): One soil map. By J. E. Lapham and party.

Soil Survey of the Provo Area, Utah (part of Utah County, 373 square miles): Two soil maps, 2 alkali maps, 2 black alkali maps (Plates II and III), 2 underground water maps. By Alfred M. Sanchez.

Soil Survey of the Leesburg Area, Virginia (parts of Loudoun County, Va., Frederick and Washington counties, Md., and Jefferson County, W. Va., 419 square miles): One soil map. By William T. Carter, jr., and W. S. Lyman.

Soil Survey of the Norfolk Area, Virginia (parts of Princess Anne, Nansemond, and Norfolk counties, 303 square miles): One soil map. By J. E. Lapham. (Exhausted.)

Soil Survey of the Viroqua Area, Wisconsin (parts of Monroe and Vernon counties, 504 square miles): One soil map. By William G. Smith.

Soil Survey of the Laramie Area, Wyoming (part of Albany County, 309 square miles): One soil map, 1 alkali map, 1 black alkali map. By N. P. Neill and party.

Field operations of the Bureau of Soils, 1904. (Sixth Report.) By Milton Whitney, Chief. With accompanying papers by assistants in charge of field parties. Pp. 1,159, pl. 1, figs. 45, maps 53. 1905. Price, $4.75.

ADVANCE SHEETS.

Soil Survey of Rhode Island (1,085 square miles): Two soil maps. By F. E. Bonsteel and E. P. Carr.

Soil Survey of the Vergennes Area, Vermont-New York (parts of Addison County, Vt., and Essex County, N. Y., 387 square miles): One soil map. By Henry J. Wilder and H. L. Belden.

Soil Survey of the Auburn Area, New York (part of Cayuga County, 461 square miles): One soil map. By J. E. Lapham and Hugh H. Bennett.

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Soil Survey of Adams County, Pennsylvania (534 square miles): One soil map. By Henry J. Wilder and H. L. Belden.

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Soil Survey of the Orangeburg Area, South Carolina (part of Orangeburg County, 710 square miles): One soil map. By Frank Bennett and party.

Soil Survey of the Charleston Area, South Carolina (parts of Charleston and Colleton counties, 352 square miles): One soil map. By F. E. Bonsteel and E. P. Carr.

Soil Survey of Dodge County, Georgia (489 square miles): One soil map. By Charles W. Ely and A. M. Griffen.

Soil Survey of the Bainbridge Area, Georgia (part of Decatur County, 364 square miles): One soil map. By Elmer O. Fippin and J. A. Drake.

Soil Survey of the Gainesville Area, Florida (parts of Alachua, Levy, and Marion counties, 485 square miles): One soil map. By Thomas D. Rice and W. J. Geib.

Soil Survey of Macon County, Alabama (621 square miles): One soil map. By Henry J. Wilder and Hugh H. Bennett.

Soil Survey of Sumter County, Alabama (893 square miles): One soil map. By William G. Smith and Fred N. Meeker.

Soil Survey of the Jackson Area, Mississippi (parts of Hinds and Rankin counties, 737 square miles): One soil map. By J. O. Martin and O. L. Ayrs.

Soil Survey of the Biloxi Area, Mississippi (part of Harrison County, 616 square miles): One soil map. By W. Edward Hearn and M. E. Carr. (Exhausted.)

Soil Survey of De Soto Parish, Louisiana (825 square miles): One soil map. By Grove B. Jones and La Mott Ruhlen.

Soil Survey of Anderson County, Texas (1,069 square miles): One soil map. By William T. Carter, jr., and A. E. Kocher.

Soil Survey of the Austin Area, Texas (parts of Bastrop, Caldwell, Hays, Travis, and Williamson counties, 705 square miles): One soil map. By A. W. Mangum and H. L. Belden.

Soil Survey of the San Antonio Area, Texas (part of Bexar County, 484 square miles): One soil map. By Thomas A. Caine and W. S. Lyman.

Soil Survey of Lawrence County, Tennessee (618 square miles): One soil map. By Charles N. Mooney and O. L. Ayrs.

Soil Survey of the Greeneville Area, Tennessee-North Carolina (parts of Greene, Hawkins, Cocke, and Sullivan counties, Tenn., and Madison County, N. C., 664 square miles): One soil map. By Charles N. Mooney and O. L. Ayrs.

Soil Survey of Warren County, Kentucky (533 square miles): One soil map. By Thomas D. Rice and W. J. Geib.

Soil Survey of the Wooster Area, Ohio (parts of Wayne, Stark, and Summit counties, 469 square miles): One soil map. By Thomas A. Caine and W. S. Lyman.

Soil Survey of Coshocton County, Ohio (551 square miles): One soil map. By Thomas D. Rice and W. J. Geib.

Soil Survey of the Munising Area, Michigan (part of Alger County, 407 square miles): One soil map. By Thomas D. Rice and W. J. Geib.

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Soil Survey of Scott County, Indiana (197 square miles): One soil map. By A. W. Mangum and N. P. Neill.

Soil Survey of the Boonville Area, Indiana (parts of Warrick and Spencer counties, 264 square miles): One soil map. By A. W. Mangum and N. P. Neill.

Soil Survey of the Superior Area, Wisconsin-Minnesota (parts of Douglas County, Wis., and St. Louis County, Minn., 483 square miles): One soil map. By Thomas A. Caine and W. S. Lyman.

Soil Survey of Tama County, Iowa (720 square miles): One soil map. By Charles W. Ely, George N. Coffey, and A. M. Griffen.

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Soil Survey of the O'Fallon Area, Missouri-Illinois (parts of Lincoln, St. Charles, and St. Louis counties, Mo., and Calhoun County, Ill., 620 square miles): One soil map. By Elmer O. Fippin and J. A. Drake.

Soil Survey of Webster County, Missouri (605 square miles): One soil map. By J. A. Drake and A. T. Strahorn.

Soil Survey of the Kearney Area, Nebraska (parts of Dawson, Buffalo, Phelps, Kearney, and Gosper counties, 792 square miles): One soil map, 1 alkali map (colored plate). By J. O. Martin and A. T. Sweet.

Soil Survey of Allen County, Kansas (504 square miles): One soil map. By J. A. Drake and W. E. Tharp.

Soil Survey of the Garden City Area, Kansas (parts of Finney and Gray counties, 336 square miles): One soil map. By James L. Burgess and George N. Coffey.

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Soil Survey of the Greeley Area, Colorado (parts of Weld and Larimer counties, 687 square miles): One soil map. By J. Garnett Holmes and N. P. Neill.

Soil Survey of the Bear River Area, Utah (part of Box Elder County, 334 square miles): One soil map, 1 alkali map, 1 underground water map. By Charles A. Jensen and A. T. Strahorn.

Soil Survey of the Yuma Area, Arizona-California (parts of Yuma County Ariz., and San Diego County, Cal., 340 square miles): One soil map, 1 alkali map. By J. Garnett Holmes, Charles A. Jenson, Herbert W. Marean, N. P. Neill, Aldert S. Root, W. E. McLendon, J. L. Burgess, A. T. Strahorn, and A. T. Sweet.

Soil Survey of the Sacramento Area, California (parts of Sacramento, Sutter, Yuba, Placer, and Eldorado counties, 924 square miles): One soil map. By Macy H. Lapham and W. W. Mackie.

Soil Survey of the Bakersfield Area, California (part of Kern County, 195 square miles): One soil map, 1 alkali map, 1 black alkali map. By Macy H. Lapham and Charles A. Jensen.

Soil Survey of the San Bernardino Area, California (parts of Los Angeles, Riverside, and San Bernardino counties, 755 square miles): One soil map. By J. Garnett Holmes, N. P. Neill, W. E. McLendon, A. T. Sweet, Aldert S. Root, and Herbert W. Marean.

Field operations of the Bureau of Soils, 1905. (Seventh Report.) By Milton Whitney, Chief. With accompanying papers by assistants in charge of field parties. Pp. 1,089, pl. 2, figs. 45, maps 47. 1906. Price, $4.50.

ADVANCE SHEETS.

Soil Survey of Blount County, Alabama (625 square miles): One soil map. By William G. Smith and F. N. Meeker.

Soil Survey of Dallas County, Alabama (992 square miles): One soil map. By E. P. Carr, W. Edward Hearn, Hugh H. Bennett, and R. T. Avon Burke.

Soil Survey of Lauderdale County, Alabama (708 square miles): One soil map. By F. E. Bonsteel, Orla L. Ayrs, Thomas D. Rice, and E. P. Carr.

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Soil Survey of Montgomery County, Alabama (780 square miles): One soi map. By W. E. McLendon and Charles J. Mann.

Soil Survey of the Stockton Area, California (part of San Joaquin County 521 square miles): One soil map, 1 alkali map (colored plate), 1 blac alkali map (colored plate). By Macy H. Lapham and W. W. Mackie.

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Soil Survey of Newton County, Indiana (393 square miles): One soil map By N. P. Neill and W. E. Tharp.

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Soil Survey of Brown County, Kansas (573 square miles): One soil map By James L. Burgess and W. E. Tharp.

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Soil Survey of the Crystal Springs Area, Mississippi (parts of Simpson and Copiah counties, 231 square miles): One soil map. By James L Burgess and W. E. Tharp.

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Soil Survey of Sarpy County, Nebraska (227 square miles): One soil map. By A. E. Kocher and Lewis A. Hurst.

Soil Survey of the Binghamton Area, New York (part of Broome County. 229 square miles): One soil map. By Elmer O. Fippin and William T. Carter, jr.

Soil Survey of Tompkins County, New York (493 square miles): One soil map. By Jay A. Bonsteel, Elmer O. Fippin, and William T. Carter, jr.

Soil Survey of Duplin County, North Carolina (824 square miles): One soil map. By Aldert S. Root and Lewis A. Hurst.

Soil Survey of Pasquotank and Perquimans counties, North Carolina (461 square miles): One soil map. By J. E. Lapham and W. S. Lyman. (Exhausted.)

Soil Survey of the Carrington Area, North Dakota (parts of Foster and Griggs counties, 432 square miles): Two soil maps. By A. E. Kocher and Lewis A. Hurst.

Soil Survey of the Cleveland Area, Ohio (parts of Lorain, Summit, Cuyahoga, and Medina counties, 509 square miles): One soil map. By J. E. Lapham and Charles N. Mooney.

Soil Survey of the Westerville Area, Ohio (parts of Delaware, Franklin, Licking, Madison, and Union counties, 476 square miles): One soil map. By J. E. Lapham and Charles N. Mooney.

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Soil Survey of Chester County, Pennsylvania (760 square miles): One soil map. By Henry J. Wilder, W. J. Geib, Thomas A. Caine, and William T. Carter, jr. (Exhausted.)

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Soil Survey of the Yorktown Area, Virginia (Elizabeth City, York, James City, Gloucester, and Warwick counties, 598 square miles): One soil map. By R. T. Avon Burke and Aldert S. Root.

Soil Survey of Island County, Washington (233 square miles): One soil map. By E. P. Carr and A. W. Mangum.

Soil Survey of the Everett Area, Washington (part of Snohomish County, 525 square miles): One soil map. By E. P. Carr and A. W. Mangum.

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Soil Survey of Portage County, Wisconsin (797 square miles): One soil map. By F. N. Meeker and R. T. Avon Burke.

Field Operations of the Bureau of Soils, 1906. (Eighth Report.) By Milton Whitney, Chief. With accompanying papers by assistants in charge of field parties. Pp. 1,033, figs. 34, maps 35. 1908. Price $4.40.

ADVANCE SHEETS.

Soil Survey of Lee County, Alabama (629 square miles): One soil map. By W. Edward Hearn and W. J. Geib.

Soil Survey of the Fayetteville Area, Arkansas (parts of Benton and Washington counties, 569 square miles): One soil map. By Henry J. Wilder and Charles F. Shaw.

Soil Survey of Prairie County, Arkansas (613 square miles): One soil map. By William T. Carter, jr., F. N. Meeker, Howard C. Smith, and E. L. Worthen.

Soil Survey of Escambia County, Florida (575 square miles): One soil map. By A. M. Griffen, J. A. Drake, H. L. Belden, and L. A. Kolbe.

Soil Survey of the Waycross Area, Georgia (part of Ware County, 535 square miles): One soil map. By M. Earl Carr and W. E. Tharp.

Soil Survey of Greene County, Indiana (535 square miles): One soil map. By W. E. Tharp and Charles J. Mann.

Soil Survey of the Tishomingo Area, Indian Territory (part of District No. 22, 343 square miles): One soil map. By Thomas D. Rice and Orla L. Ayrs.

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Soil Survey of Riley County, Kansas (635 square miles): One soil map. By William T. Carter, jr., and Howard C. Smith.

Soil Survey of Caddo Parish, Louisiana (869 square miles): Two soil maps. By James L. Burgess, Lewis A. Hurst, Henry J. Wilder, and Charles F. Shaw.

Soil Survey of Cass County, Michigan (500 square miles): One soil map. By W. J. Geib.

Soil Survey of Blue Earth County, Minnesota (749 square miles): One soil map. By Hugh H. Bennett and Lewis A. Hurst.

Soil Survey of the Crookston Area, Minnesota (part of Polk County, 779 square miles): One soil map. By A. W. Mangum and Frank C. Schroeder.

Soil Survey of Montgomery County, Mississippi (370 square miles): One soil map. By Thomas A. Caine and Frank C. Schroeder.

Soil Survey of Pontotoc County, Mississippi (368 square miles): One soil map. By Frank Bennett and R. A. Winston.

Soil Survey of Putnam County, Missouri (523 square miles): One soil map. By Charles J. Mann and W. E. Tharp.

Soil Survey of Lancaster County, Nebraska (858 square miles): One soil map. By James L. Burgess and E. L. Worthen.

Soil Survey of Merrimack County, New Hampshire (923 square miles): One soil map. By Charles N. Mooney, H. L. Westover, and Frank Bennett.

Soil Survey of Niagara County, New York (547 square miles): One soil map. By Elmer O. Fippen, Grove B. Jones, W. J. Geib, Orla L. Ayrs, and C. W. Mann.

Soil Survey of Madison County, New York (649 square miles): One soil map. By M. Earl Carr, A. M. Griffen, and Ora Lee, jr. (Exhausted.)

Soil Survey of Chowan County, North Carolina (178 square miles): One soil map. By W. Edward Hearn, assisted by G. M. MacNider, of the State department of agriculture.

Soil Survey of New Hanover County, North Carolina (18 square miles): One soil map. By J. A. Drake and H. L. Belden. (Exhausted.)

Soil Survey of Transylvania County, North Carolina (372 square miles): One soil map. By W. Edward Hearn, assisted by G. M. MacNider, of the State department of agriculture.

Soil Survey of Ransom County, North Dakota (856 square miles): One soil map. By Charles W. Ely, assisted by Rex E. Willard and J. T. Weaver.

Soil Survey of the Williston Area, North Dakota (part of Williams County, 585 square miles): One soil map. By Thomas D. Rice.

Soil Survey of Meigs County, Ohio (443 square miles): One soil map. By F. N. Meeker and G. W. Tailby, jr.

Soil Survey of Oklahoma County, Oklahoma (650 square miles): One soil map. By W. E. McLendon and Grove B. Jones.

Soil Survey of Grainger County, Tennessee (307 square miles): One soil map. By W. E. McLendon and W. S. Lyman.

Soil Survey of Madison County, Tennessee (561 square miles): One soil map. By W. S. Lyman, W. E. McLendon, and Frank Bennett.

Soil Survey of the Henderson Area, Texas (part of Rusk County, 506 square miles): One soil map. By Charles W. Ely and A. E. Kocher.

Soil Survey of the Laredo Area, Texas (part of Webb County, 156 square miles): One soil map. By A. W. Mangum and Ora Lee, jr.

Soil Survey of the San Marcos Area, Texas (parts of Hays, Guadalupe, Caldwell, and Bastrop counties, 420 square miles): One soil map. By A. W. Mangum and W. S. Lyman.

Soil Survey of Chesterfield County, Virginia (478 square miles): One soil map. By Frank Bennett, R. A. Winston, W. J. Geib, and C. W. Mann.

Soil Survey of the Wheeling Area, West Virginia (all of Ohio, Brooke, and Hancock counties, and part of Marshall County, 315 square miles): One soil map. By Thomas A. Caine and G. W. Tailby, jr.

Soil Survey of Racine County, Wisconsin (326 square miles): One soil map. By Grove B. Jones and Orla L. Ayrs.

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Field Operations of the Bureau of Soils, 1907. (Ninth Report.) By Milton Whitney, Chief. With accompanying papers by assistants in charge of field parties. Pp. 1062, figs. 36, maps 35. 1909. Price $4.50.

ADVANCE SHEETS.

Soil Survey of Butler County, Alabama (771 square miles): One soil map. By A. E. Kocher and H. L. Westover.

Soil Survey of Marion County, Alabama (739 square miles): One soil map. By Orla L. Ayrs, E. R. Allen, A. E. Kocher, and H. L. Westover.

Soil Survey of Talladega County, Alabama (750 square miles): One soil map. By Charles N. Mooney and Charles J. Mann.

Soil Survey of Conway County, Arkansas (574 square miles): One soil map. By James L. Burgess and Charles W. Ely.

Soil Survey of the Colusa area, California (parts of Glenn, Colusa, Tehama, and Butte counties, 756 square miles): One soil map, 1 alkali map. By Macy H. Lapham, A. T. Sweet, A. T. Strahorn, and L. C. Holmes.

Soil Survey of the Redding area, California (part of Shasta County, 200 square miles): One soil map. By Macy H. Lapham and L. C. Holmes.

The Soils of the Butte Valley, California. (Reconnoissance.) By W. W. Mackie.

Soil Survey of Jefferson County, Florida (585 square miles): One soil map. By Grove B. Jones, W. E. Tharp, and H. L. Belden.

Soil Survey of the Minidoka area, Idaho (parts of Lincoln and Cassia counties, 146 square miles). By A. T. Strahorn and C. W. Mann.

Soil Survey of Marion County, Indiana (389 square miles): One soil map. By W. J. Geib and Frank C. Schroeder.

Soil Survey of Winn Parish, Louisiana (957 square miles): One soil map. By Thomas A. Caine, H. L. Belden, and L. L. Lee.

Soil Survey of the Easton area, Maryland (Queen Anne, Talbot, and Caroline counties, 967 square miles). By Hugh H. Bennett, W. E. Tharp, W. S. Lyman, and H. L. Westover.

Soil Survey of Prentiss County, Mississippi (415 square miles): One soil map. By W. J. Geib and C. W. Mann.

Soil Survey of Oktibbeha County, Mississippi (446 square miles): One soil map. By W. E. McLendon and Lewis A. Hurst.

Soil Survey of Jasper County, Mississippi (675 square miles): One soil map. By E. L. Worthen and H. Jennings.

Soil Survey of the North Platte area, Nebraska (part of Lincoln County, 470 square miles): One soil map. By E. L. Worthen and O. L. Eckman.

Soil Survey of Dutchess County, New York (800 square miles): One soil map. By Charles N. Mooney and H. L. Belden.

Soil Survey of Henderson County, North Carolina (366 square miles): One soil map. By W. Edward Hearn, assisted by G. M. MacNider, of the State department of agriculture.

Soil Survey of Edgecombe County, North Carolina (515 square miles): One soil map. By W. Edward Hearn, assisted by G. M. MacNider, of the State department of agriculture.

Soil Survey of the McKenzie area, North Dakota (part of McKenzie County, 348 square miles): One soil map. By A. E. Kocher, assisted by R. P. Stevens, of the Agricultural and Economic Geological Survey of North Dakota.

Soil Survey of the Morton area, North Dakota (parts of Morton and Hettinger counties, 544 square miles): One soil map. By Thomas D. Rice, assisted by Ray Babcock and John T. Weaver.

Soil Survey of the Johnstown area, Pennsylvania (parts of Cambria, Blair, and Bedford counties, 714 square miles): One soil map. By C. J. Mann and Howard C. Smith.

Soil Survey of Lee County, South Carolina (410 square miles): One soil map. By Frank Bennett, G. W. Tailby, jr., James L. Burgess, W. J. Latimer, and H. L. Westover.

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Soil Survey of Oconee County, South Carolina (652 square miles): One soil map. By W. E. McLendon and W. J. Latimer.

Soil Survey of Sumter County, South Carolina (587 square miles): One soil map. By Frank Bennett, G. W. Tailby, jr., James L. Burgess, Grove B. Jones, W. J. Latimer, and H. L. Westover.

Soil Survey of the Bellefourche area, South Dakota (parts of Butte and Meade counties, 190 square miles): One soil map. By A. T. Strahorn and C. W. Mann.

Soil Survey of Giles County, Tennessee (614 square miles): One soil map. By Orla L. Ayrs.

Soil Survey of the Brownsville area, Texas (part of Cameron County, 189 square miles): One soil map. By A. W. Mangum and Ora Lee, jr.

Soil Survey of Bastrop County, Texas (917 square miles): One soil map. By R. A. Winston, F. N. Meeker, O. L. Eckman, W. S. Lyman, Frank C. Schroeder, Thomas D. Rice, and H. C. Smith.

Soil Survey of the Cooper area, Texas (Delta County and part of Lamar County, 625 square miles): One soil map. By Thomas D. Rice and H. C. Smith.

Soil Survey of Robertson County, Texas (852 square miles): One soil map. By Hugh H. Bennett and Charles F. Shaw.

Soil Survey of Wilson County, Texas (783 square miles): One soil map. By W. S. Lyman and Frank C. Schroeder.

Soil Survey of Montgomery County, Virginia (393 square miles): One soil map. By R. A. Winston and Ora Lee, jr.

Soil Survey of the Bellingham area, Washington (part of Whatcom County, 384 square miles): One soil map. By A. W. Mangum and Lewis A. Hurst.

Soil Survey of the Middlebourne area, West Virginia (Marshall, Tyler, and Wetzel counties, 952 square miles): One soil map. By Thomas A. Caine, E. R. Allen, H. Jennings, and G. W. Tailby, jr.

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